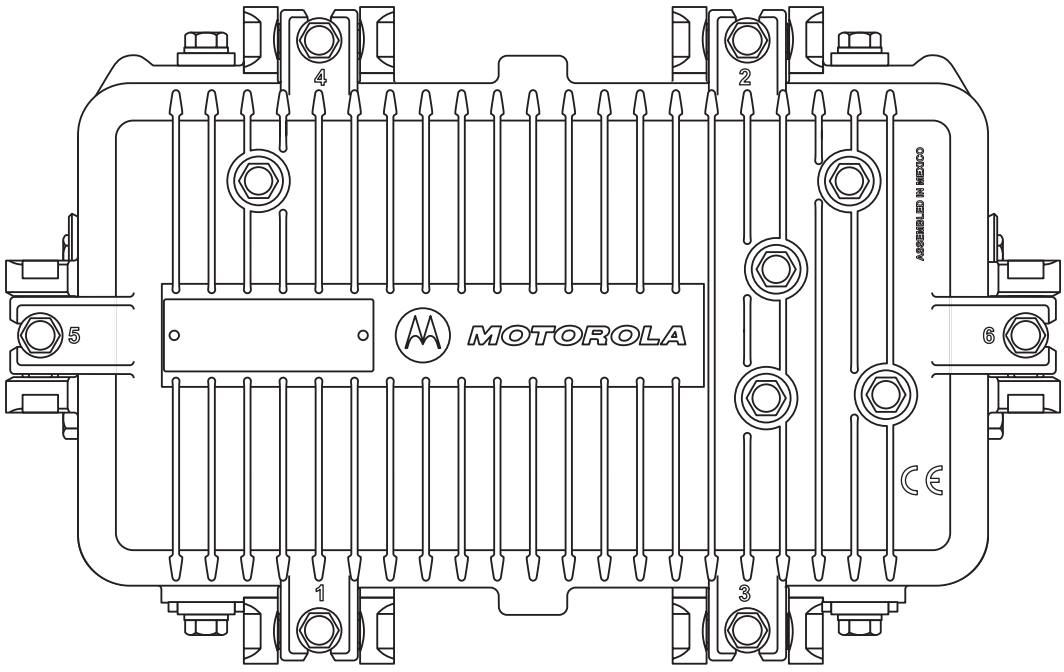
STARLINE® SERIES

MB*/*
MiniBridger Amplifiers

Installation and Operation Manual



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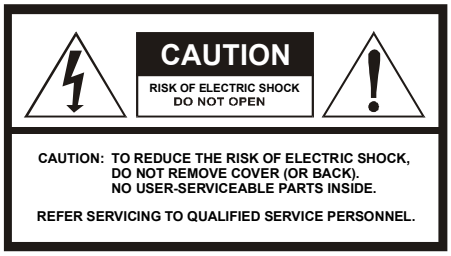
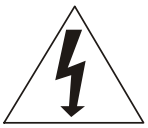

CAUTION
RISK OF ELECTRIC SHOCK
DO NOT OPEN
CAUTION: TO REDUCE THE RISK OF ELECTRIC SHOCK,
DO NOT REMOVE COVER (OR BACK).
NO USER-SERVICEABLE PARTS INSIDE.
REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.

Caution

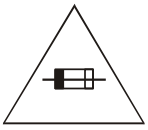
These servicing instructions are for use by qualified personnel only. To reduce the risk of electrical shock, do not perform any servicing other than that contained in the Installation and Troubleshooting Instructions unless you are qualified to do so. Refer all servicing to qualified service personnel.

Special Symbols That Might Appear on the Equipment



This symbol indicates that dangerous voltage levels are present within the equipment. These voltages are not insulated and may be of sufficient strength to cause serious bodily injury when touched. The symbol may also appear on schematics.

The exclamation point, within an equilateral triangle, is intended to alert the user to the presence of important installation, servicing, and operating instructions in the documents accompanying the equipment.



For continued protection against fire, replace all fuses only with fuses having the same electrical ratings marked at the location of the fuse.

Electrostatic discharge (ESD) can damage the MB*/* unit and circuit card assemblies. Wear an antistatic wrist strap attached to a chassis ground to prevent ESD damage.

This equipment operates over the marked Voltage and Frequency range without requiring manual setting of any selector switches. Different types of line cord sets may be used for connections to the mains supply circuit and should comply with the electrical code requirements of the country of use.

It is recommended that the customer install an AC surge arrestor in the AC outlet to which this device is connected. This is to avoid damaging the equipment by local lightning strikes and other electrical surges.

FCC Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the Installation Manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his/her own expense. Any changes or modifications not expressly approved by Motorola could void the user's authority to operate this equipment under the rules and regulations of the FCC.

You may find the following booklet, prepared by the Federal Communication Commission, helpful: *How to Identify and Resolve Radio-TV Interference Problems*, Stock No. 004-000-0342-4, U.S. Government Printing Office, Washington, DC 20402.

Changes or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Canadian Compliance

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.
Cet appareil numérique de la classe A respects toutes les exigences du Règlement sur le matériel brouilleur du Canada.

International Declaration of Conformity

We — Motorola, Inc.
101 Tournament Drive
Horsham, PA 19044, U.S.A.

declare under our sole responsibility that the

STARLINE — Model MB*/*

to which this declaration relates is in conformity with one or more of the following standards:

EMC Standards

EN55022 EN55024 EN55013 EN50083-2 CISPR-22 CISPR-24 CISPR-13

Safety Standards

EN60065 EN60825 EN50083-1 EN60950 IEC 60950 + A1: 1992 + A2: 1993 + A3: 1995 + A4: 1996

IEC60065

following the provisions of the Directive(s) of the Council of the European Union:

EMC Directive 89/336/EEC — Low Voltage Directive 73/23/EEC

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Contents

Section 1
Introduction

Using This Manual 1-2
Related Documentation 1-3
Document Conventions 1-3
If You Need Help 1-3
Calling for Repairs 1-4

Section 2
Overview

Configuration 2-2
Housing 2-3
Gaskets 2-5
Port Locations 2-6
Power Supply 2-6
Forward Path 2-9
    Models SP and DC 2-11
Return Path, RA-Kit/H or RA-Kit/L 2-12
Ingress Control Switch 2-12
Options and Accessories 2-14

Section 3
Amplifier Setup

Forward Path Alignment 3-1
    Before You Begin 3-1
    Cable Equalizer 3-2
        Example 1 3-2
        Example 2 3-2
    Cable Simulators 3-5
    Input, Midstage, and Output Pads 3-6
    Output Passives 3-7
    Flatness Control 3-8
    Directional Coupler Test Points 3-12
    Bode Equalization 3-12
    Amplifier Level Control 3-12
    Manual Gain Control 3-12
    Thermal Drive Unit 3-14

Automatic Drive Unit 3-15
ADU Pads and Levels 3-15
Return Path Alignment 3-16
Before You Begin 3-16
Alignment Procedure 3-17
Powering and Surge Protection 3-18

Section 4
Bench Testing

Before You Begin 4-1
Test Equipment and Connections 4-2
Measuring Forward Gain 4-3
Example 4-3
Testing Return Gain and Response 4-4
Example 4-5
Completing the Test Procedures 4-5

Section 5
Installation

Aerial Installation 5-1
Pedestal Installation 5-3

Section 6
Operating Tips

Using Amplifiers in Lower Frequency Systems 6-1
Using Amplifiers in Lower Gain Systems 6-1

Appendix A
Specifications

Model MB87S/XG* A-1
Model MB87S/XX* A-2
Model MB75S/XG* A-3
Model MB75S/XX* A-4
AC Current, MB75*/*, MB87*/* A-4
RA-Kit/H Return Amplifier A-5
ADU Automatic Drive Unit A-5

Appendix B
Torque Specifications

Abbreviations and Acronyms

Figures

Figure 1-1 MB*/* — closed 1-2
Figure 2-1 MB*/* — open 2-1
Figure 2-2 MB*/* configurator 2-2
Figure 2-3 MB-HSG dimensions — top view 2-3
Figure 2-4 MB-HSG dimensions — side view 2-3
Figure 2-5 MBP-HSG dimensions 2-4
Figure 2-6 Housing gaskets 2-5
Figure 2-7 Housing ports 2-6
Figure 2-8 MPPS-II block diagram 2-7
Figure 2-9 MPPS-II power pack 2-7
Figure 2-10 60/90 volt selector 2-8
Figure 2-11 Power passing fuse locations 2-9
Figure 2-12 MB*/* dual output block diagram 2-10
Figure 2-13 MB*/S*single output block diagram 2-11
Figure 2-14 LL-MB-F3 status monitor 2-13
Figure 2-15 MB*/* options and accessories 2-15
Figure 3-1 Equalizer slope versus cable 3-4
Figure 3-2 Frequency versus cable slope 3-6
Figure 3-3 SP splitter 3-7
Figure 3-4 DC/* directional coupler 3-7
Figure 3-5 Flatness controls 3-8
Figure 3-6 MDR-*MB/*/II board 3-9
Figure 3-7 Effects of flatness controls on the MDR-8MB/*/II board 3-10
Figure 3-8 Effect of flatness controls on the main board: 3-11
Figure 3-9 TDU cable selector 3-14
Figure 3-10 ADU 3-15
Figure 4-1 Test equipment connections for bench sweeping 4-2
Figure 5-1 Center-conductor pin length 5-1
Figure 5-2 Torque sequence 5-2

Tables

Table 2-1 MB*/* options and accessories 2-14
Table 3-1 Starline Forward Equalizers — SFE-*-* 3-3
Table 3-2 Starline cable simulators 3-5
Table 3-3 Gain reserve versus ambient temperature 3-13
Table 3-4 MB*/* AGC pad levels 3-16

Section 1

Introduction

The Motorola® STARLINE® series of MiniBridger amplifiers, model MB*/*, accept a single input and provide high operational gain to a single or dual output. The high gain makes the MB*/* series ideally suited for a hybrid fiber-coax system as well as conventional tree-and-branch designs. The MB*/* amplifier series complies with IEEE C62.41-1991 and Bell Core GR-1098 specifications for overvoltage testing as recommended by Cable Labs. The MB*/* platform is also FCC and CE approved.

Features of the MB*/* include:

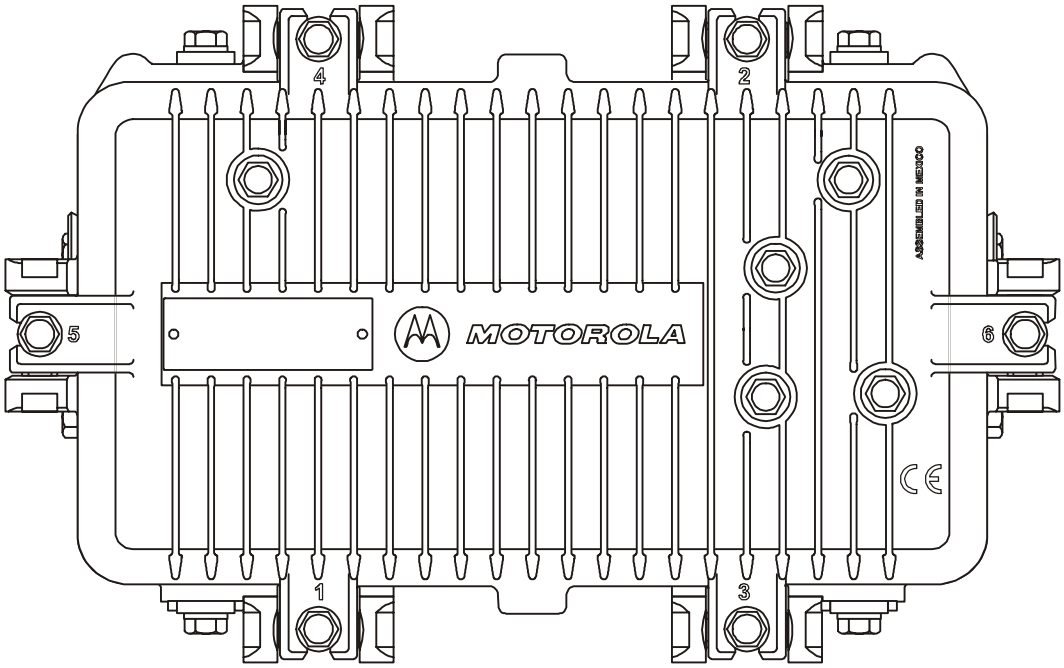
- 750 MHz or 870 MHz power doubling technology (in enhanced gallium arsenide (E-GaAs) or silicon)
- Several different modular diplex filter splits
- "Ease of use" ergonomics
- 60/90 Vac line power option
- Power factor corrected power supply
- Thermal and auto-controlled Bode equalization
- –20 dB directional coupler test points
- Optional return path ingress control and LIFELINE® status monitor
- Two-way capability
- 15-amp power passing

Features of the optional MB*/* bypass housing include:

- Amplifier bypass for maintenance and upgrades
- Accommodation of the optional bypass amplifier
- Use of a quick-connect interface probe for RF/AC bypassing
- A reversible amplifier module
- 90-degree port entries
- 15-amp, 1 GHz electrical performance

Figure 1-1 illustrates a closed MB*/*:

Figure 1-1
MB*/* — closed



Using This Manual

The following sections provide information and instructions to install and operate the MB*/*.

Section 1	**Introduction** provides a product description, related documentation, the technical help line, and repair/return information.
Section 2	**Overview** describes the MB*/* and includes details on the various options and their functions.
Section 3	**Amplifier Setup** provides instructions for full configuration and forward- and return-path alignment.
Section 4	**Bench Testing** describes the bench test procedures that are recommended before you install the MB*/*.
Section 5	**Installation** provides instructions for installing the MB*/* and options.
Section 6	**Operating Tips** provides suggestions for handling field-encountered variables and addressing maintenance tasks.
Appendix A	**Specifications** lists the applicable technical specifications for the MB*/* and options.
Appendix B	**Torque Specifications** provides the appropriate torque specifications for the MB*/* and options.
Abbreviations and Acronyms	The **Abbreviations and Acronyms** list contains the full spelling of the short forms used in this manual.

This manual assumes that all channels are standard National Television Standards Committee (NTSC) analog channels. Refer to catalog specifications for further details pertaining to signal levels of digital channels above 550 MHz.

This manual also uses 870 MHz as the reference frequency unless another frequency is given. For example, quoted cable loss is understood to be at 870 MHz.

Related Documentation

This Installation and Operation Manual is complete and you should not require any additional documentation to install, test, or operate the MB*/*.

Document Conventions

Before you begin using the MB*/*, familiarize yourself with the stylistic conventions used in this manual:

SMALL CAPS	Denotes silk screening on the equipment, typically representing front- and rear-panel controls and input/output (I/O) connections, and LEDs
* (asterisk)	Indicates that several versions of the same model number exist and the information applies to all models; when the information applies to a specific model, the complete model number is given
Italic type	Denotes a displayed variable, or is used for emphasis

If You Need Help

If you need assistance while working with the MB*/*, contact the Motorola Technical Response Center (TRC):

- Inside the U.S.: **1-888-944-HELP** (**1-888-944-4357**)
- Outside the U.S.: **215-323-0044**
- Online: http://www.motorola.com/broadband, click **HTML/Modem Version**, click **Customer Support**, then click **Web Support**.

The TRC is open from 8:00 AM to 7:00 PM Eastern Time, Monday through Friday and 10 AM to 6 PM Eastern Time, Saturday. When the TRC is closed, emergency service *only* is available on a call-back basis. Web Support offers a searchable solutions database, technical documentation, and low priority issue creation/tracking 24 hours per day, 7 days per week.

Calling for Repairs

If repair is necessary, call the Motorola Repair Facility at **1-800-642-0442** for a Return for Service Authorization (RSA) number before sending the unit. The RSA number must be prominently displayed on all equipment cartons. The Repair Facility is open from 7:00 AM to 4:00 PM Pacific Time, Monday through Friday.

When calling from outside the United States, use the appropriate international access code and then call **52-631-311-1100**, to contact the Repair Facility.

When shipping equipment for repair, follow these steps:

1. Pack the unit securely.
2. Enclose a note describing the exact problem.
3. Enclose a copy of the invoice that verifies the warranty status.
4. Ship the unit **PREPAID** to the following address:

   Motorola, Inc.
   Broadband Communications Sector
   c/o Excel
   Attn: RSA #_____
   6908 East Century Park Drive
   Suite 100
   Tucson, AZ 85706

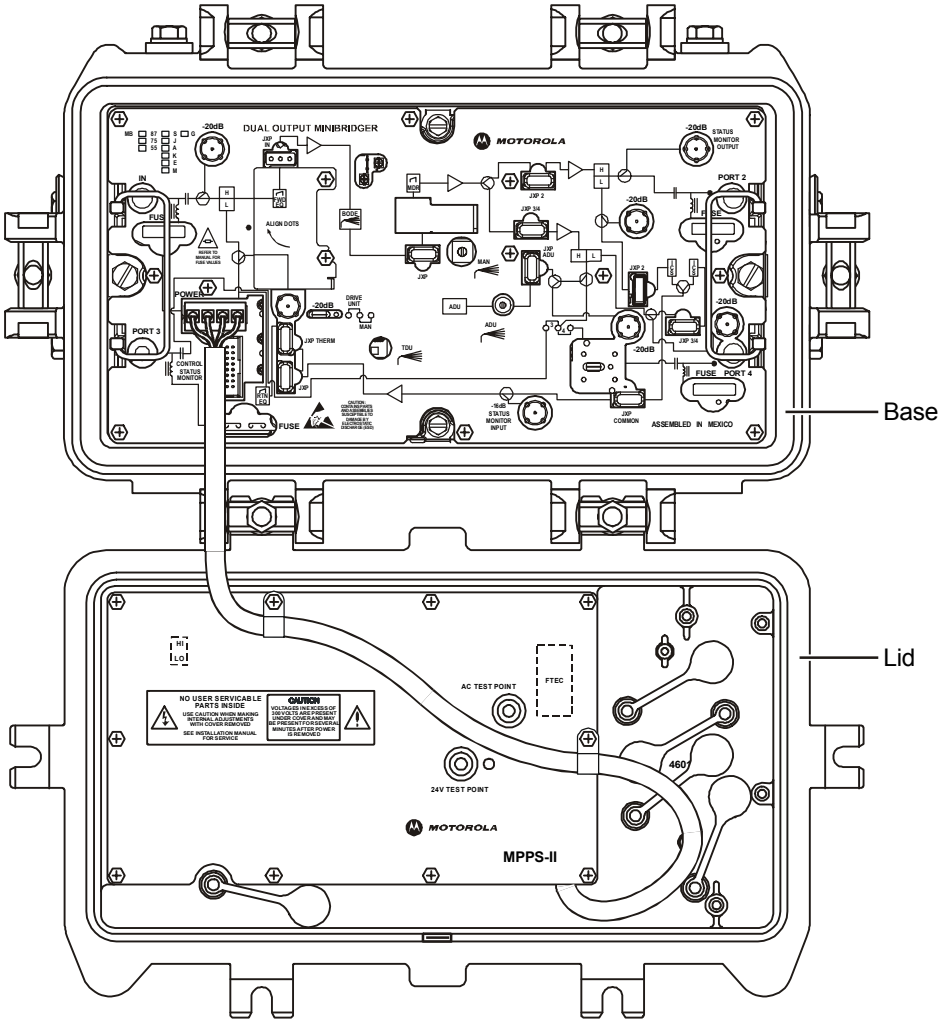
Section 2

Overview

The MB*/* is a dual-output amplifier while the MB*/S* is a single-output amplifier used in CATV distribution systems. Both models accommodate installation of the optional return amplifier to enable two-way signal flow. All models are high-gain, three-stage hybrid amplifers designed to drive both a limited cascade and a local distribution system. The MB*/* is powered by the 60/90 Vac cable supply and can be configured to pass this power to additional amplifiers and line extenders.

The standard model MB*/* includes an amplifier module with an integrated power supply which is normally furnished complete in the model MB-HSG housing as illustrated in Figure 2-1:

Figure 2-1
MB*/* — open

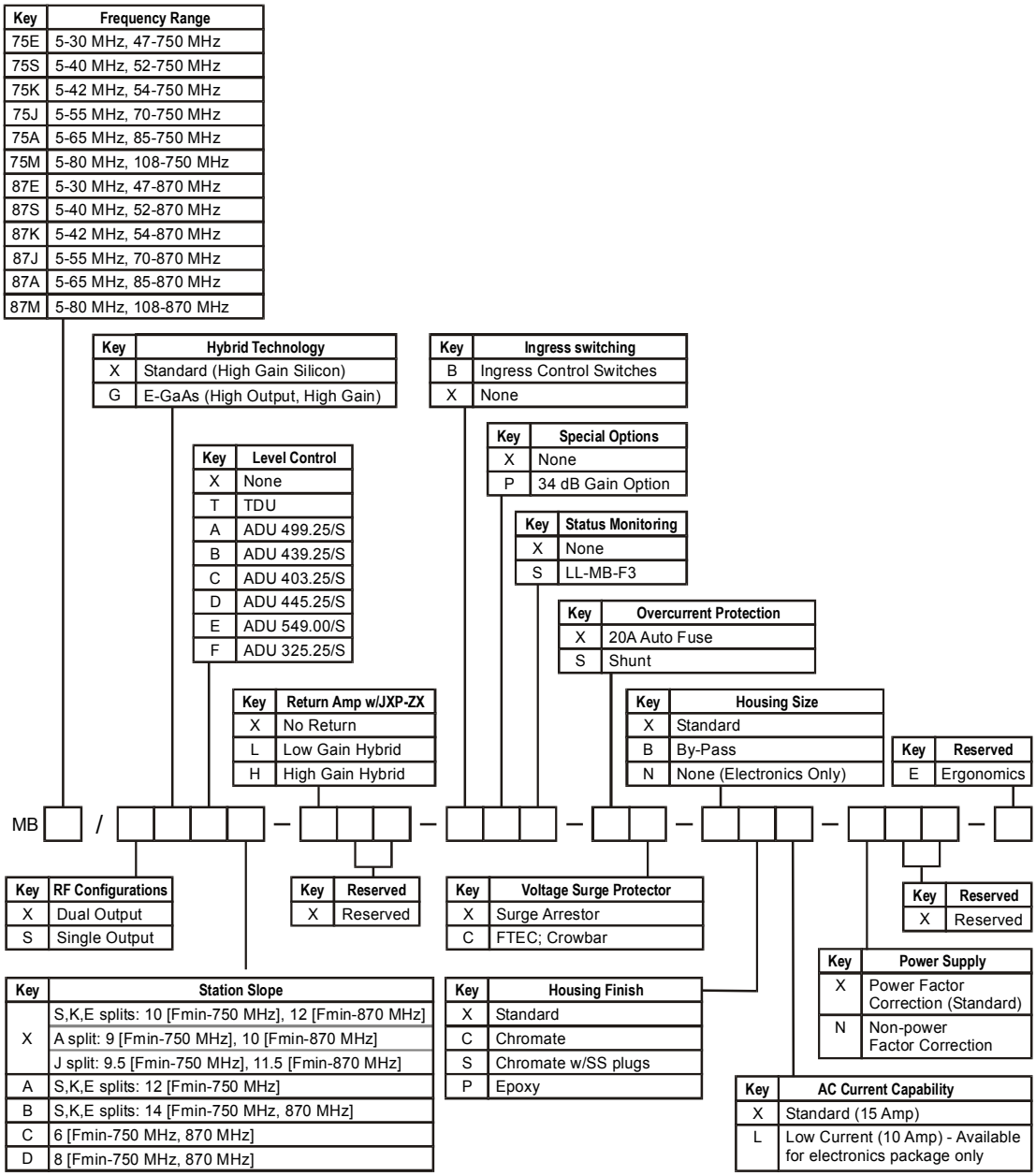


Configuration

The MB*/* is fully configured in the factory per customer request. It is recommended that you verify the configuration listed on the outside of the shipping carton with the configuration that you ordered. The shipped configuration is also noted in a label on the side of the electronics chassis and the housing.

Figure 2-2 illustrates the MB*/* configuration notation:

Figure 2-2
MB*/* configurator



Housing

The MB*/* is furnished in an MB-HSG aluminum housing that protects the electronics from weather and dissipates internally generated heat.

Figure 2-3 illustrates a top view of the MB-HSG housing and provides its dimensions:

Figure 2-3
MB-HSG dimensions — top view

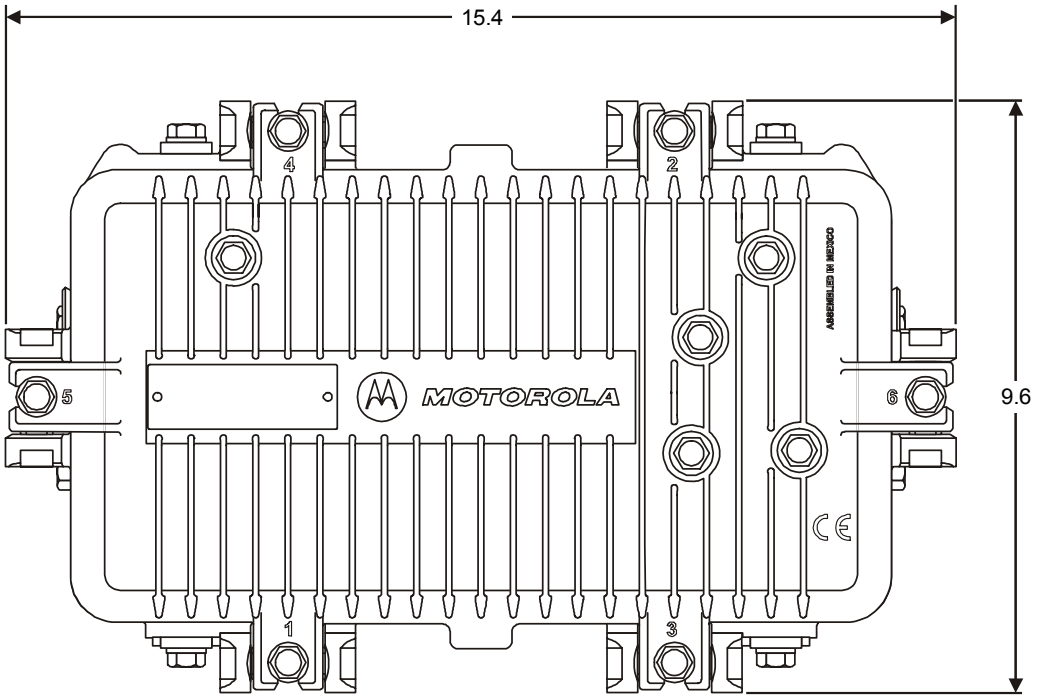


Figure 2-4 illustrates a side view of the MB-HSG and provides its dimensions:

Figure 2-4
MB-HSG dimensions — side view

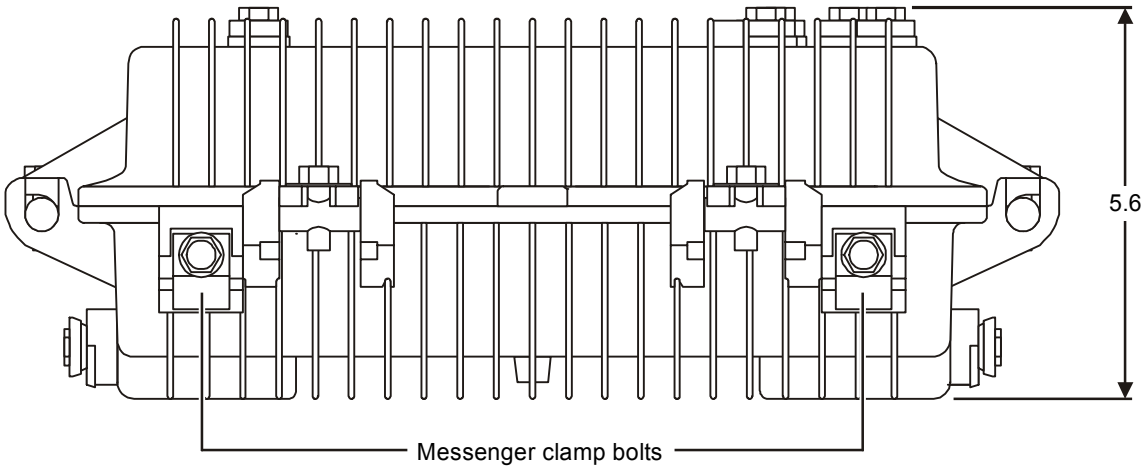
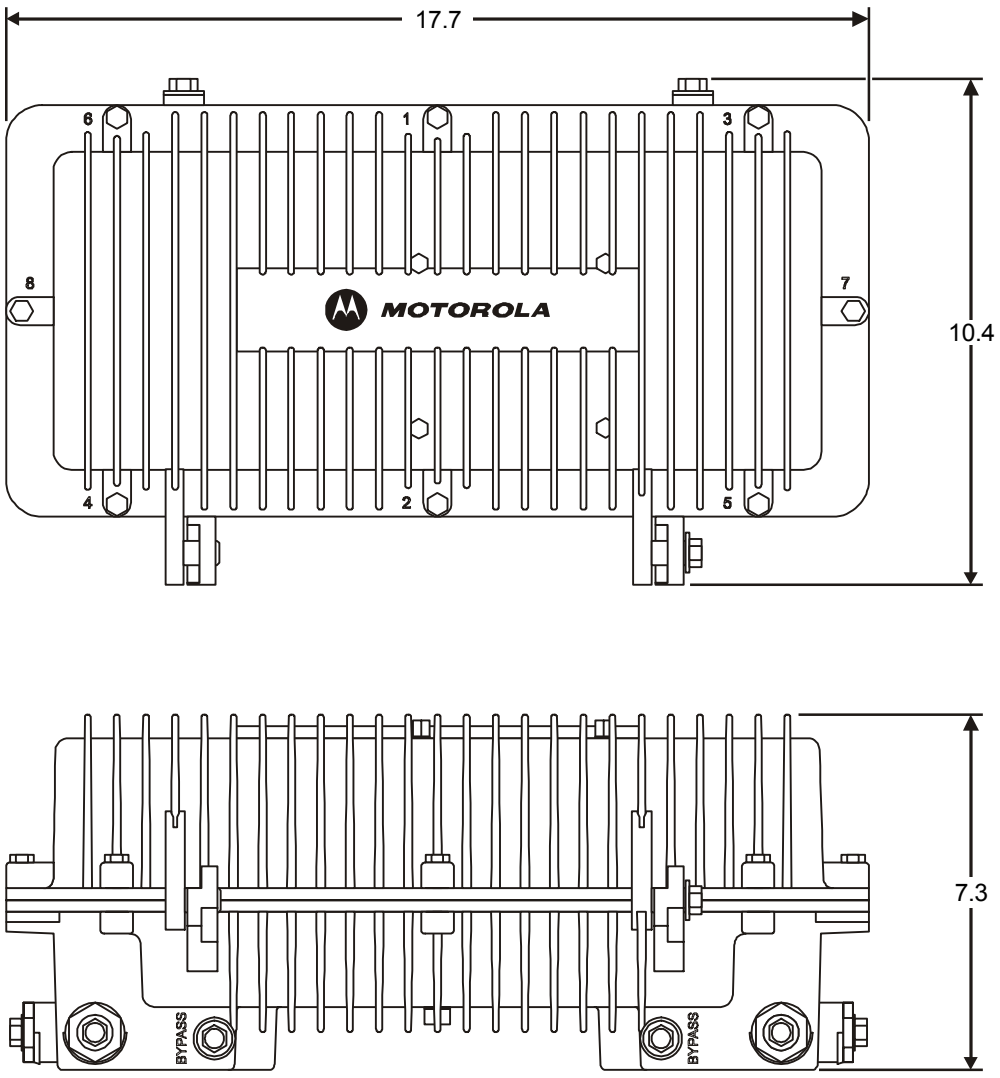


Figure 2-5 provides top and side view dimensions of the optional MBP-HSG bypass housing:

Figure 2-5
MBP-HSG dimensions



Coaxial cable connections to the housing are made using conventional 5/8 × 24 threads per-inch stinger-type connectors. Five port plugs in the cover enable access to internal test points without opening the housing.

The interior platform assembly of the 15A MB-HSG differs from the platform assembly of the 10A MB-HSG (earlier models MB-550D-H, MB-750D-H, and MB-75SH, AH, and JH). However, you can upgrade the 10A MB*/* to a 15A MB*/* using existing housings. To upgrade the MB-550D-H or MB-750D-H, use the MB-15A kit P/N 951941-005-00. To upgrade the MB-75SH, AH, or JH, use the MB-15AII platform assembly kit P/N 951941-007-00. Both kits can be used in either the standard or bypass housing. Replacing the housing cover brings the test ports in line with the output test points for both the forward and return signal path.

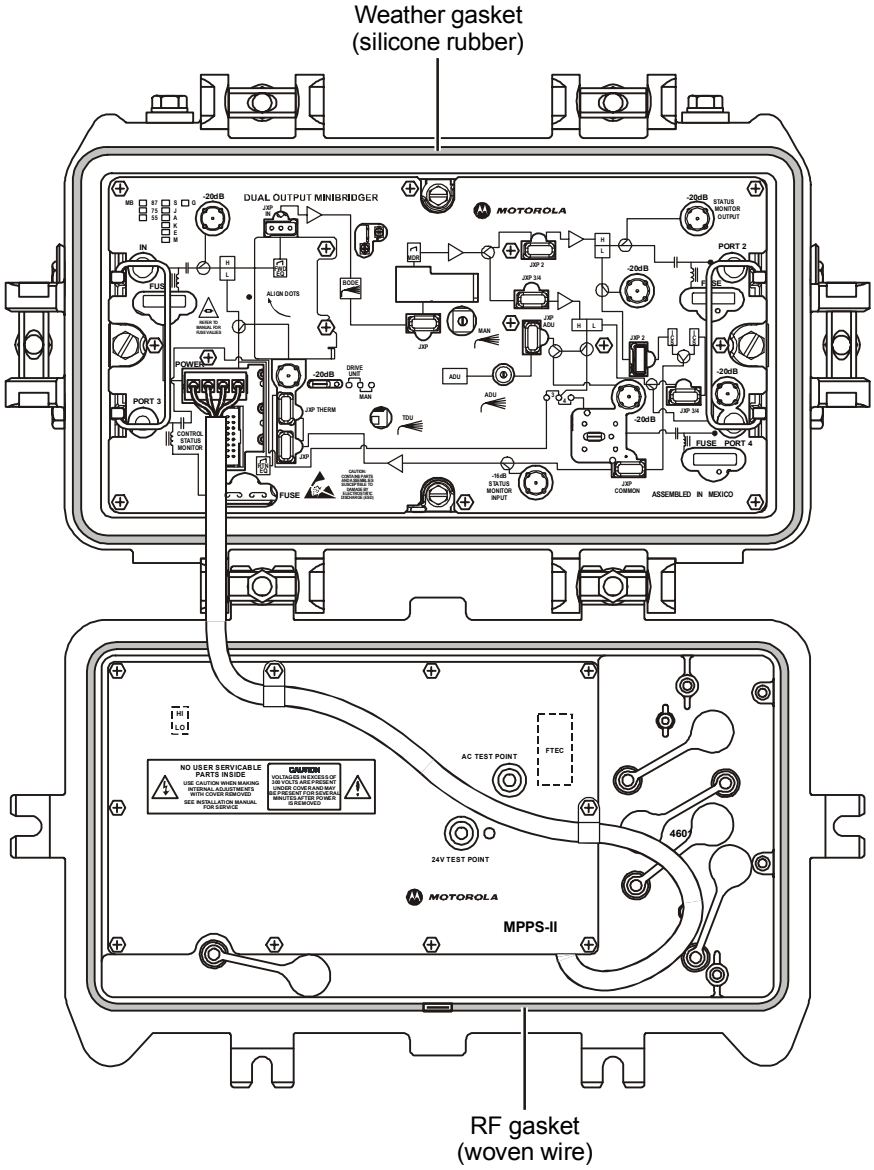
The included clamp and bolt assemblies enable you to mount the standard and bypass housings. For instructions on aerial and pedestal installation refer to Section 5, “Installation”.

Gaskets

Each housing is equipped with a recessed woven-wire RF gasket and a silicone-rubber weather gasket to provide a seal between the housing base and lid. These gaskets provide efficient ground continuity, RF shielding, and weather protection. Both gaskets must be in place and in good condition to ensure proper operation and protection of the station. The weather gasket should be lightly coated with silicone grease each time the amplifier is opened. Replace this gasket if it becomes damaged or deformed.

Figure 2-6 illustrates the housing gaskets:

Figure 2-6
Housing gaskets

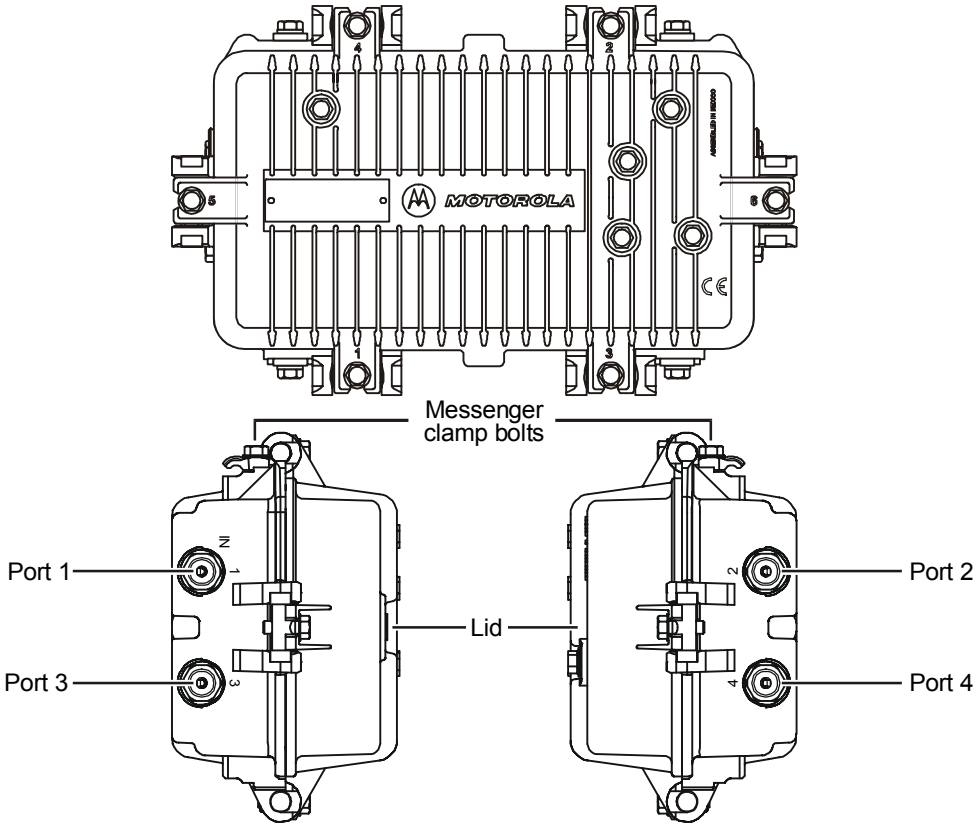


Port Locations

Five port plugs in the cover enable access to internal test points. The input and output ports provide connection for coaxial cables and are protected by factory-inserted threaded plugs or plastic cap plugs. Discard the plastic cap plugs when you install the cable connectors.

Figure 2-7 illustrates the housing port locations:

Figure 2-7
Housing ports



Power Supply

The cover of the amplifier houses the model MPPS-II 60/90 power pack. It provides a regulated 24 Vdc output at 1.8 amps maximum over an ac input voltage range from 38 Vac to 90 Vac rms. The input voltage waveshape is either a squarewave or a sinewave. The surge protector and the EMI filter protect the power pack and amplifier from transient spikes. An integral fast-acting zener diode provides additional surge protection.

The preregulator is a fixed frequency switching regulator that presents a near perfect power factor to the input line and provides overvoltage and overcurrent protection. A precision output regulator provides a precise output voltage and is also protected against overcurrent and short circuits. If a short circuit is detected, the power supply shuts down and the regulator initiates a sequence of line test pulses at approximately one-half second intervals. The regulator continues these pulses for the duration of the short circuit but returns to normal operation when the fault is cleared.

Figure 2-8 illustrates a block diagram of the MPPS-II power pack:

Figure 2-8
MPPS-II block diagram

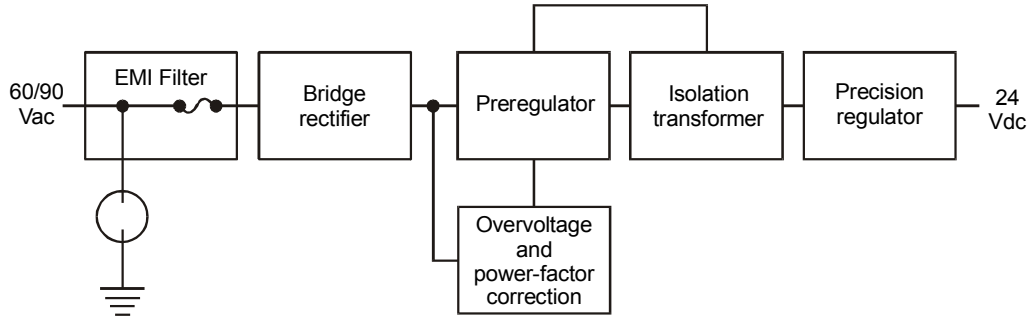
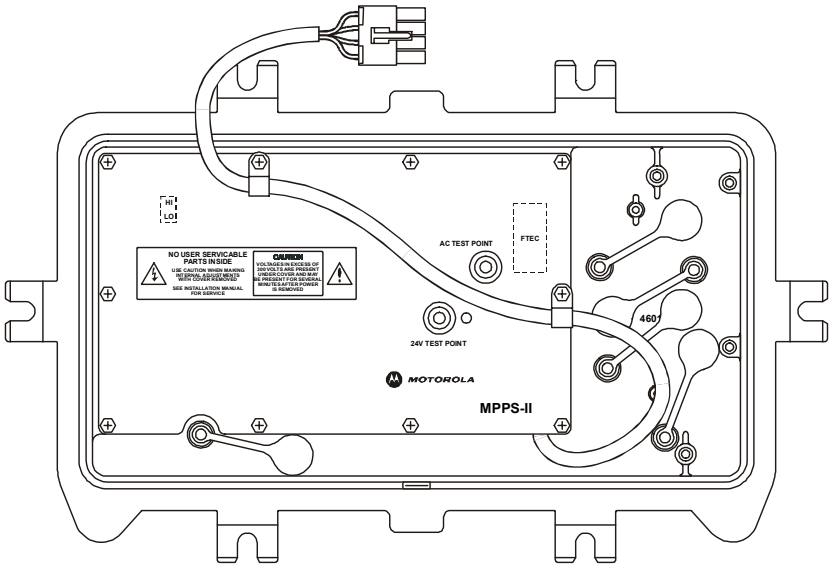


Figure 2-9 illustrates the MPPS-II installed in the upper half of the MB-HSG:

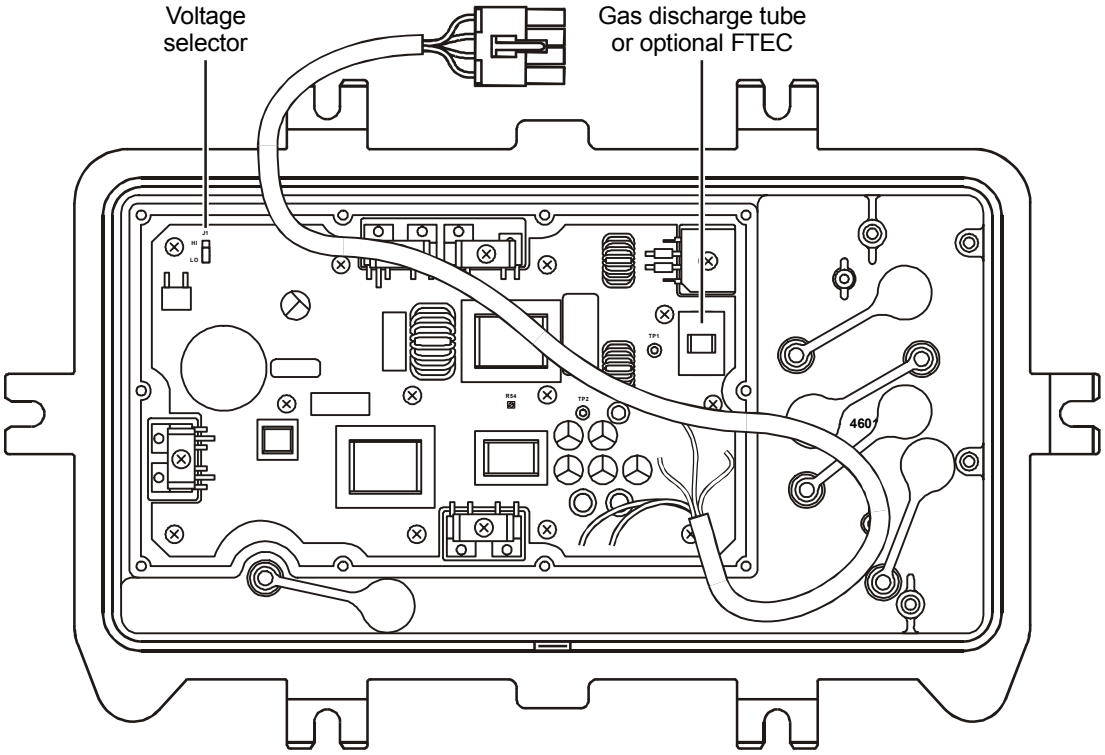
Figure 2-9
MPPS-II power pack



The MPPS-II also contains a two position LO/HI selector that sets the *start-up voltage* for 38 Vac or 55 Vac. The MB*/* is shipped with the selector in the LO position which is the standard configuration. The selector should be switched to the HI position only for a 90 Vac system. This sets the start-up voltage at 55 Vac. Because this is only 5 V below 60 Vac, it is not practical to switch to HI in a 60 Vac system. There is no damage to the amplifier if the selector is not changed from the standard LO setting. However, changing the selector ensures that the dc supply does not turn on until the proper input voltage, 38 Vac or 55 Vac, is reached. This prevents excessive loading of the system power supply during turn-on after a system shutdown.

Figure 2-10 illustrates the location of the LO/HI voltage selector and the gas discharge tube surge protector on the MPPS-II:

Figure 2-10
60/90 volt selector

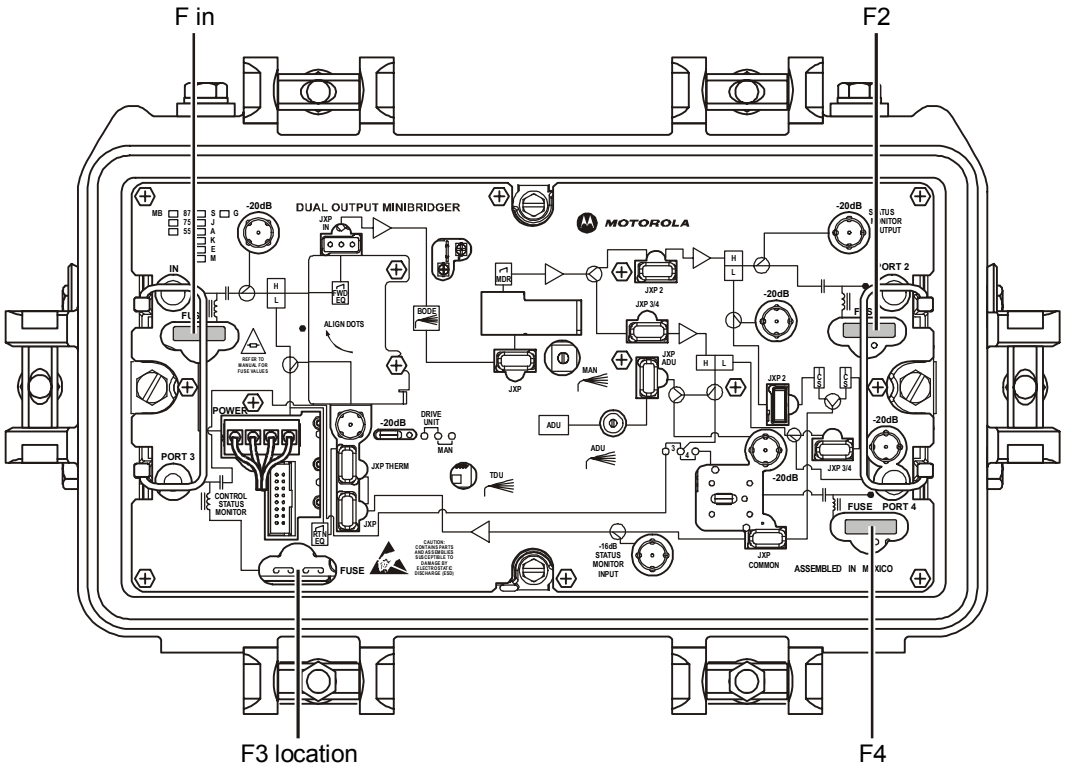


You must remove the MPPS-II cover to access the selector illustrated in Figure 2-10. Section 3, “Amplifier Setup” explains changing the setting of this selector to meet system requirements.

The power supply includes a heavy-duty gas discharge tube which you can replace with the optional fast-transfer electronic-crowbar (FTEC) surge protector. The FTEC fires at approximately 245 V and presents a short circuit to the line during periods of overvoltage. After the ac input voltage returns to normal, the FTEC resumes its open state.

Factory installed 20-amp fuses, illustrated in Figure 2-11, provide power passing to additional amplifiers:

Figure 2-11
Power passing fuse locations



Forward Path

The operational gain of all MB*/* models is 40 dB with 16 dB of return loss in the forward path. The operating gain includes provisions for the insertion loss of the input cable equalizer and required reserve gain to operate the Bode equalizer in the middle of its range.

The forward path's electronics consist of two parallel three-stage paths consisting of: (1) pre-amplifier (input hybrid), (2) intermediate amplifier (midstage hybrid), and (3) power-doubling output hybrid stage. The first two stages are common to both paths. The pre-amplifier stage provides a low noise figure while the output stage contributes the preferred power at low distortion. The amplifier input provides a facility to install a cable equalizer and a socket for a model JXP-*B attenuator. The attenuator and equalizer are customer installed options.

Several circuits comprise the intermediate amplifier stages. A flatness control circuit enables optimization of the frequency response. The Bode equalizer is a voltage-controlled device that, in the standard configuration, receives its input from the manual gain control. It also receives its input from the automatic drive unit (ADU-*) or thermal drive unit (TDU-*) when either of these options is employed.

Following the Bode board, a JXP pad facility adjusts the RF level into the interstage hybrid amplifier and the MDR-*MB/*/II controls flatness and provides equalization. Because these losses are located interstage, the noise figure is only significantly impacted by the insertion loss of the forward cable equalizer or broadband cable simulator, and the input pad if its value is increased from zero.

Following the interstage hybrid is a JXP-*B pad socket (or a splitter and two JXP-*B pad sockets for dual output) leading into the power-doubling output stage.

Figure 2-12 illustrates the interconnection between these components in the dual-output MB*/*:

Figure 2-12
MB*/* dual output block diagram

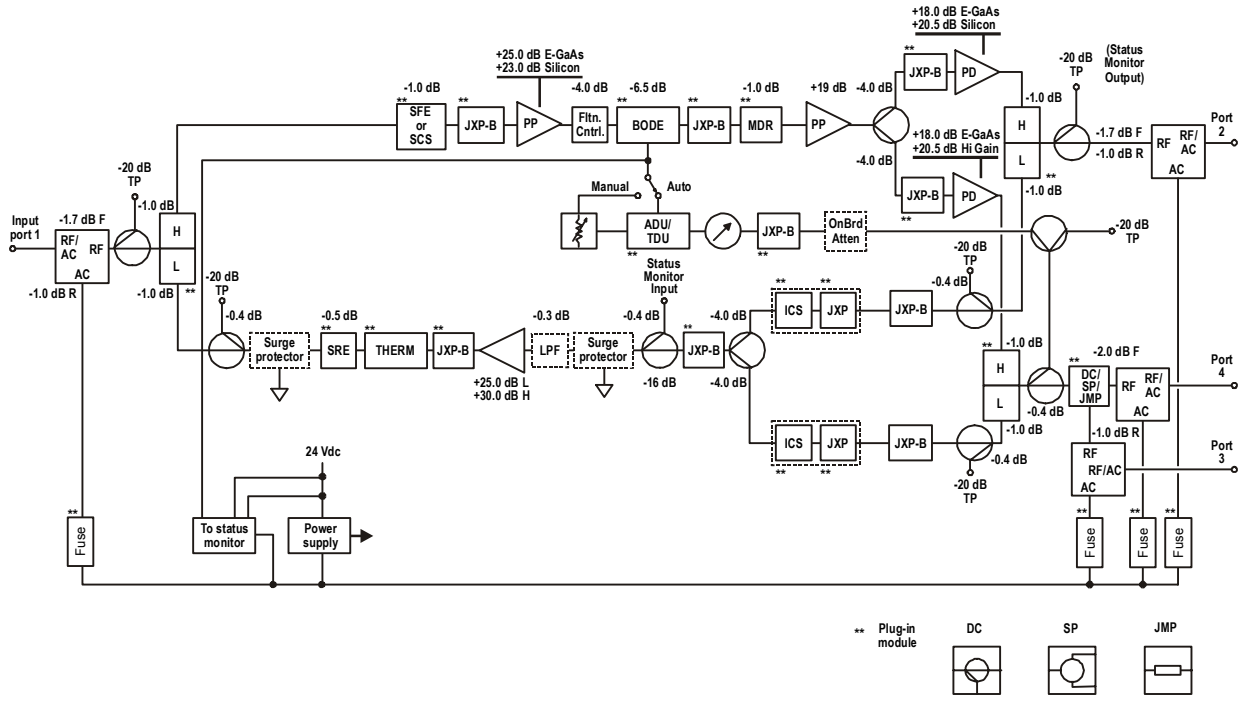
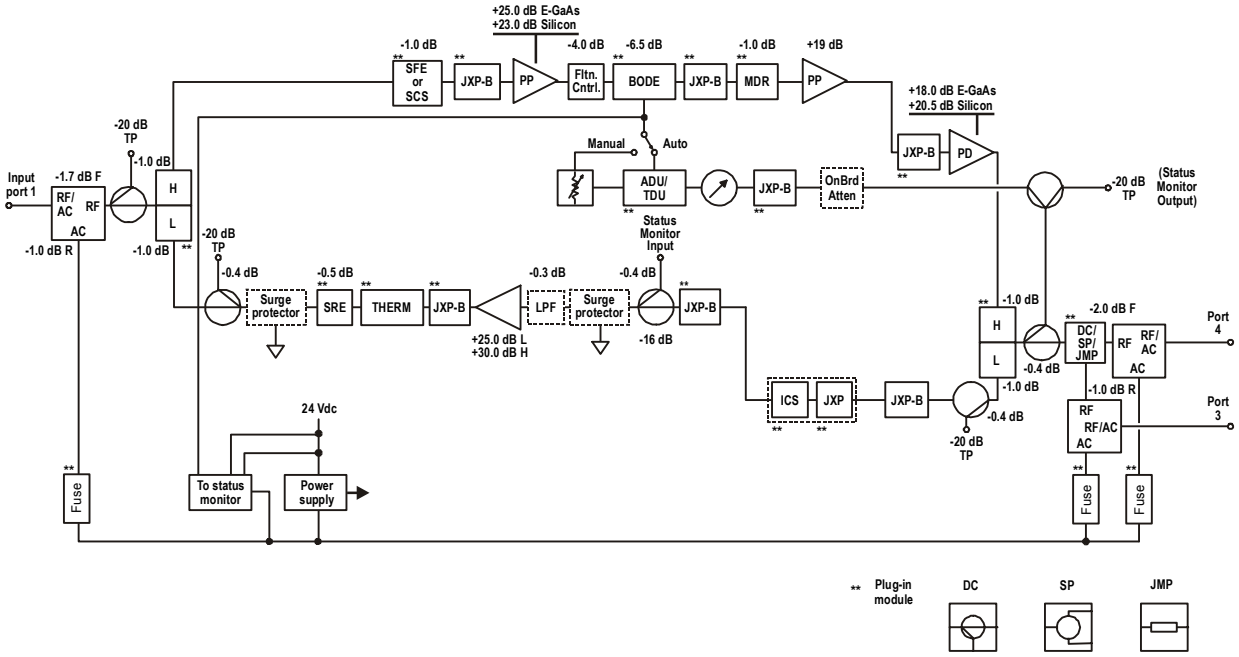


Figure 2-13 illustrates the interconnection between these components in the single output MB*/S*:

Figure 2-13
MB*/S*single output block diagram



Accurate –20 dB directional coupler test points are available at the input and at the output of the amplifier. Because these test points are 75-ohm source impedance, they do not require special test probes.

After the output amplifier, a second directional coupler provides signal to the optional ADU board. As this signal is used only with the ADU, you do not need to terminate this port when the ADU is not installed.

Models SP and DC

Port 2 is a dedicated amplifier path in the MB*/*. The other path can feed port 3 or port 4 depending on where you install the furnished JMP jumper. The model SP splitter and model DC/* directional coupler provide output at both ports 3 and 4. The SP provides equal output levels, while the DC/* provides one high-level port and one low-level port. The high-level signal is routed to port 3 or port 4 and is based on the orientation of the DC/* during installation. Figure 2-1 illustrates the port numbers identified on the amplifier cover and Figure 2-7 illustrates the port numbers cast into the MB-HSG.

When installing a DC/ or an SP, complete the installation and install fuse F3 before you apply RF power.*

Return Path, RA-Kit/H or RA-Kit/L

The circuit board of the MB*/* amplifier accommodates the optional return path. The return path kit, Model RA-Kit/H or RA-Kit/L, includes the return amplifier hybrid (illustrated in Figure 2-15) and jumpers. This equips the MB*/* to pass signals in the return or upstream direction. The standard circuit board contains all components including the diplex filters, with extended return bandwidth, for the amplifier input and output.

Optional SRE-*-* return equalizers compensate for cable attenuation and are available in 1 dB increments for S-split, and 2 dB increments for all other splits, from 0 dB through 12 dB. All items are plug-in and easily installed.

There are JXP-*B pad facilities located at the input and output of the return path. You can use these pad facilities as test points or signal injection points. The output pad value is normally selected to control the return signal level into the next upstream amplifier. Select an appropriate input pad to attenuate excessive input signal.

The return-input test points and the return-output test point are –20 dB directional couplers. These test points present 75-ohm source impedance and do not require special test probes.

Ingress Control Switch

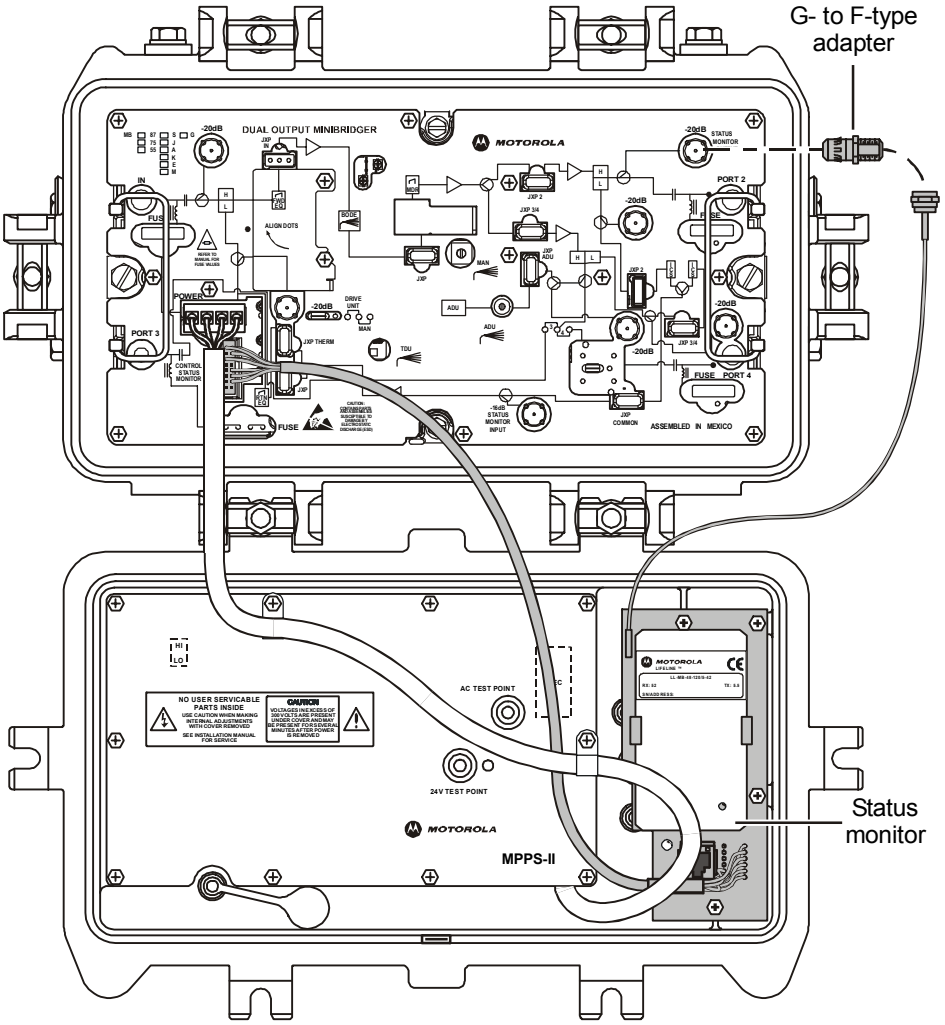
The ingress control switches (ICS) (illustrated in Figure 2-15) provide return-path signal attenuation or cutoff in the MB*/*. The dual output MB*/* requires two ICS's. Switching is accomplished through the frequency agile LIFELINE Flexstat 3 status-monitoring module, LL-MB-F3, located in the housing lid next to the power supply, as illustrated in Figure 2-14.

The ICS provides a means of isolating sources of ingress from a centralized location. Using a downstream command through the LIFELINE status-monitoring system, you can attenuate the return path through the amplifier by 6 dB or by 38 dB. By reducing the ingress level at the headend or monitoring point, you can further isolate the ingress source.

After you isolate an ingress source to the last possible amplifier, node, or line extender, you can shut the return path off at that location. This limits the impact of the ingress on the remainder of the network while eliminating the source of ingress.

Figure 2-14 illustrates the LL-MB-F3 and the required cable connections to the amplifier module:

Figure 2-14
LL-MB-F3 status monitor



Options and Accessories

The factory ships the MB*/* as a fully functional unit, but you must configure it appropriately for the field location requirements. You must install the correct forward equalizer or broadband cable simulator and input pad to place the unit in service. Section 3, “Amplifier Setup” provides information to assist you in this task. Use model JXP-*B pads to control field signal levels. To compensate for temperature, install the ADU or TDU before placing the MB*/* in service. You can install other items such as a return amplifier and additional surge protection at your discretion, but these options do not render the MB*/* inoperative if they are not included.

Table 2-1 provides a comprehensive list of options and accessories for the MB*/*:

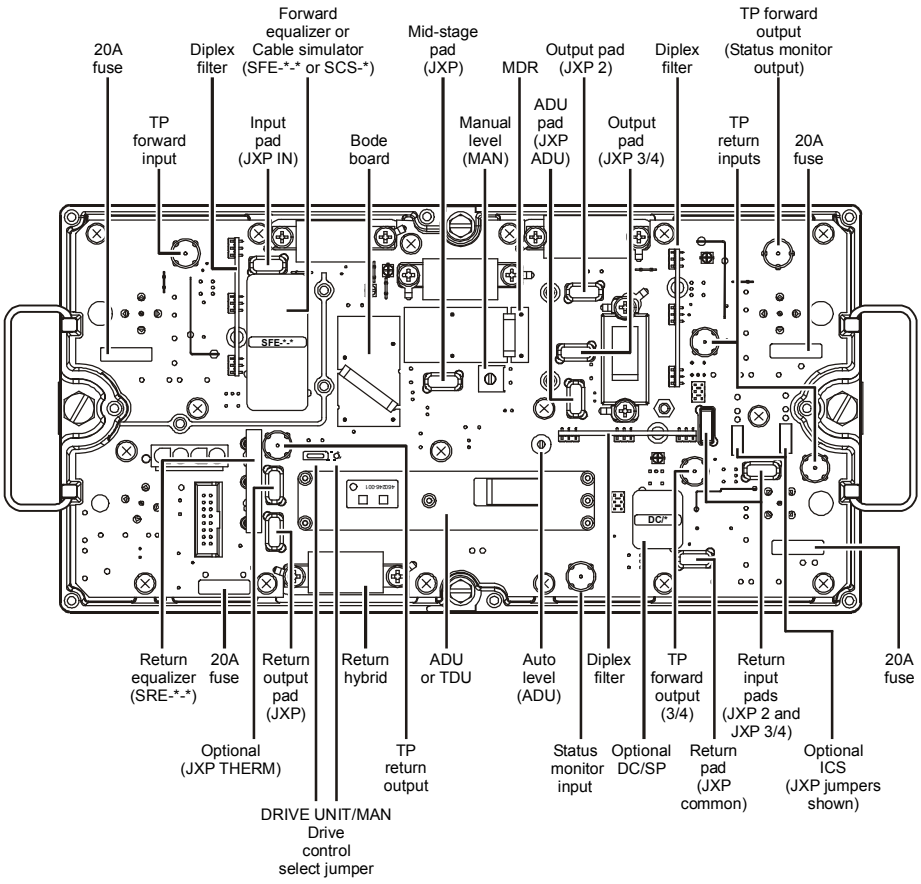
Table 2-1
MB*/* options and accessories

Model	Description	Function
ADU-*	Automatic Drive Unit	This board automatically controls amplifier output levels that change with cable attenuation and hybrid output. The selection of a pilot frequency is required.
TDU	Thermal Drive Unit	This board controls amplifier gain and slope for changes in cable attenuation for the sensed temperature.
RA-Kit/H or L	Return Amplifier Kit	This kit enables two-way operation and includes a high- or low-gain return hybrid and jumpers.
SFE-0, SFE-1	Starline Forward Equalizer	These equalizers are not bandwidth specific and compensate for 0 dB and 1 dB of cable respectively from 5 MHz to 1 GHz.
SFE-*-*	Starline Forward Equalizer	This bandwidth specific (750 or 870 MHz) equalizer compensates for cable properties in 1 dB increments from 2 dB to 22 dB. You must install the appropriate value. See the product catalog for additional information.
SRE-*-*	Starline Return Equalizer	This bandwidth specific equalizer compensates for cable attenuation in 1 dB increments from 0 dB to 12 dB for S-split (2 dB increments for all other splits). You must install the appropriate value. See the product catalog for additional information.
SCS-*	Starline Cable Simulator	This simulator compensates for cable properties. You must install the appropriate value. See the product catalog for additional information.
JXP-*B	Fixed attenuator	This pad attenuates excessive input signal. It is available in 0.5 dB increments from 0 dB to 26 dB. You must install the appropriate value.
JXP-TH*B	Thermal attenuators	This option compensates for gain changes with temperature in the return path.
FTEC	Fast Transfer Electronic Crowbar	This option is used for overvoltage protection and replaces the existing surge protector.
LL-MB-F3	Status monitor module	This module enables monitoring of the unit’s operating parameters by the LIFELINE status-monitoring system.

Model	Description	Function
ICS	Ingress Control Switch	This option enables remote monitoring, isolation, and reduction of ingress on the return path by providing signal attenuation of 6 dB or cutoff of 38 dB typical. The unit is shipped with a jumper in this location.
SP or DC/*	Output passives	These options should be installed in place of the JMP jumper to activate the third output of the MB*/*.
JXP-RPC	Return Path Correction Board	This optional board provides additional flatness response correction in the return path for systems that must meet especially stringent return-path flatness requirements.
MBP-HSG	Bypass housing	This housing accommodates the signal bypass jumper, which prevents transmission loss to subscribers during maintenance and upgrades.

Figure 2-15 illustrates the location of options and accessories in the MB*/*:

Figure 2-15
MB*/* options and accessories



In the event of ADU or TDU board failure, you can select manual control of the Bode board. Figure 2-15 illustrates the location of the DRIVE UNIT/MAN jumper on the main circuit board.

Section 3

Amplifier Setup

This section provides instructions for fully configuring the MB*/* and describes the proper forward and return path alignment procedures. The following tasks need to be performed for successful amplifier setup:

- Forward path alignment:
  - Selecting the appropriate cable equalizer or cable simulator
  - Selecting the appropriate input, midstage, and output pads
  - Selecting the appropriate output passives
  - Verify proper flatness control
  - Verify proper level control
- Check return path alignment
- Check powering and surge protection options

It is recommended that you read this entire section before you install the MB*/*.

Forward Path Alignment

The following subsections describe the MB*/* alignment procedures required for proper performance in the forward path.

Before You Begin

Before you begin to set-up the amplifier and perform forward-path alignment, please read the following instructions and recommendations.

For proper forward alignment obtain:

- RF output levels and tilts of all MB*/*s in the forward or return path
- RF input level for the MB*/* being set up (from system design or as-built map)
- A carrier at the system's highest frequency. It can be modulated or continuous wave (CW) and should be inserted in the headend at standard video levels. This carrier is used to simplify field set-up.

It is recommended that you:

- *Install the system design value SFE-*-* and a high value (20 dB or above) input pad (JXP IN) before you install or remove the electronics chassis or apply power to the MB*/*.*

  Leave the JXP IN pad location open if a high value pad is not available. A more accurate forward input test point reading is achieved with a high value pad installed.
- Do not use wire jumpers to bypass the SFE-*-* location.
- Recognize that actual pad and SFE-*-* values may differ slightly from their design values. This is caused by factors such as walkout errors, worst-case data utilization during design and temperature variation from 70°F.

- Secure the electronics chassis in the housing and torque to 18 to 22 in-lbs. to facilitate heat transfer and avoid damage from overheating.
- Perform a bench alignment. Pre-aligning the MB*/* response on the bench (Section 4, “Bench Testing”) for a system signature simplifies field alignment.
- Field sweep the entire bandwidth of the amplifier to correct frequency response for passive signature and roll-off.
- Close the housing in accordance with the instructions in Section 5, “Installation.”

Cable Equalizer

Select the appropriate model SFE-*-* to compensate for cable attenuation versus frequency and to obtain the proper output tilt. The MB*/* is equipped with the MDR-*MB/*/II interstage equalizer and flatness board, which compensates for cable attenuation. Any cable or passive slope beyond that of the MDR-*MB/*/II must be compensated for by selecting and installing the appropriate SFE-*-* cable equalizer.

Equalizers are available in 1 dB steps from 0 dB to 22 dB. The following examples describe how to choose the correct equalizer.

Example 1

The amplifier location includes 20 dB of cable (at 870 MHz) between its input and the preceding amplifier. Consider cable loss only. Exclude any flat loss due to splitters or other passive devices. The internal equalizer, model MDR-8MB/12/II, compensates for approximately 16 dB of cable. Subtract this cable length from the 20 dB of this example (20 – 16 = 4). The SFE-87-4 is the proper equalizer in this case. With this equalizer installed, the amplifier reproduces the output tilt of the last upstream amplifier.

When selecting an equalizer, choose the next lower value if the exact value is not available or in cases where the calculated value makes two choices possible.

Example 2

The MB*/* is used in a link following a fiber node. The fiber receiver output is flat and connects to the input of the amplifier through 18 dB of cable plus passive loss. Determine which is the proper equalizer to achieve the 11 dB output tilt from the MB*/*.

Calculate the equalizer value using the following equation:

$$SLOPE_{eq} = TILT_{out} + SIG_{lo} - SIG_{hi} - SLOPE_{ieq}$$

where:
- $SLOPE_{eq}$ = required SFE-87-* slope
- $TILT_{out}$ = required amplifier output tilt
- SIG_{lo} = signal input level at 54 MHz (channel 2)
- SIG_{hi} = signal input level at 870 MHz
- $SLOPE_{ieq}$ = interstage equalizer slope (12 dB)

At an operating frequency of 870 MHz, 18 dB of cable produces approximately 3.9 dB of loss at 54 MHz. This suggests that the channel 2 signal input to the MB*/* is 14.1 dB greater (18 – 3.9 = 14.1) than at 870 MHz. Our example assumes that the high-end frequency level into the MB*/* is +12 dBmV.

Substituting this information into the above equation provides the following result:

11 dB + 26.1 dB – 12 dBmV – 12 dB = 13.1 dB

The slope of the required equalizer is 13.1 dB. Table 3-1 and the graph in Figure 3-1 show that 13.1 dB of slope is caused by approximately 18 dB of cable at 870 MHz. Therefore, the correct equalizer is model SFE-87-18.

When selecting an equalizer, choose the next lower value if the exact value is not available or in cases where the calculated value makes two choices possible.

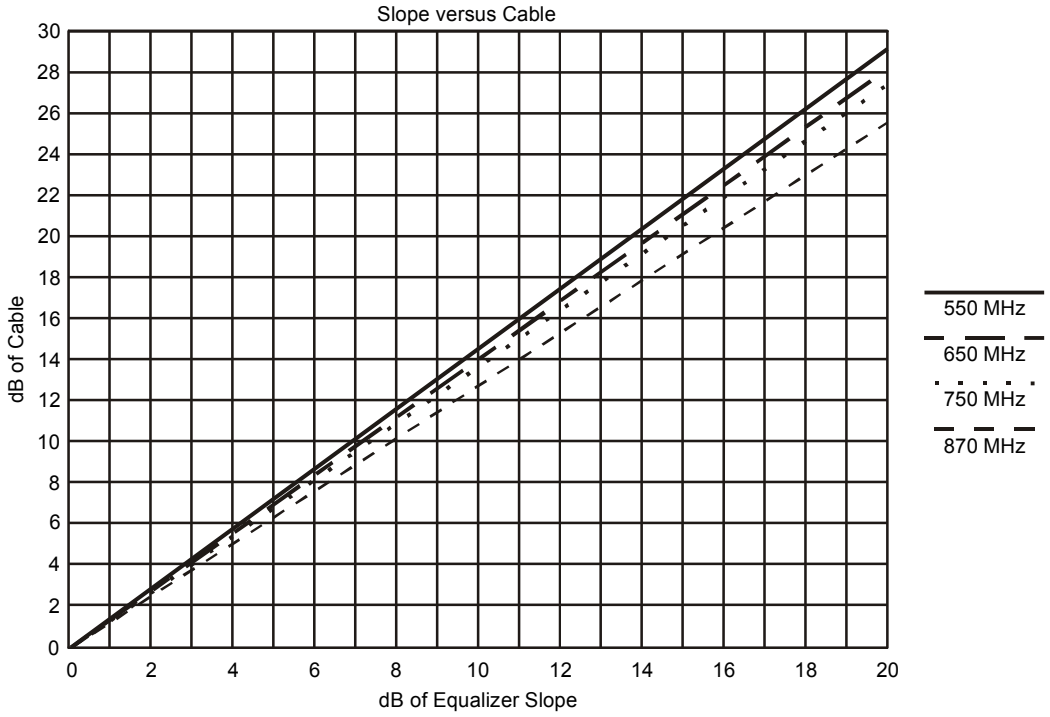
Table 3-1 helps you choose the correct equalizers and also lists insertion loss at various frequencies.

Table 3-1
Starline Forward Equalizers — SFE-*-*

		Frequency (MHz) versus Insertion Loss (dB)							
Equalizer Value	**Equalizer Slope**	**50**	**200**	**300**	**450**	**550**	**650**	**750**	**870**
SFE-75-									
22	16.3	17.3	11.6	9.1	6.0	4.2	2.5	1.0	
20	14.8	15.8	10.7	8.4	5.5	3.9	2.4	1.0	
18	13.4	14.4	9.7	7.6	5.1	3.6	2.2	1.0	
16	11.9	12.9	8.7	6.9	4.6	3.3	2.1	1.0	
14	10.4	11.4	7.8	6.1	4.2	3.0	2.0	1.0	
12	8.9	9.9	6.8	5.4	3.7	2.7	1.8	1.0	
10	7.4	8.4	5.8	4.7	3.3	2.4	1.7	1.0	
8	5.9	6.9	4.9	3.9	2.8	2.1	1.6	1.0	
6	4.5	5.5	3.9	3.2	2.4	1.9	1.4	1.0	
4	3.0	4.0	2.9	2.5	1.9	1.6	1.3	1.0	
2	1.5	2.5	2.0	1.7	1.5	1.3	1.1	1.0	
SFE-87-									
22	16.7	17.7	12.4	10.0	7.1	5.4	3.9	2.5	1.0
20	15.2	16.2	11.4	9.2	6.5	5.0	3.6	2.3	1.0
18	13.7	14.7	10.3	8.4	6.0	4.6	3.4	2.2	1.0
16	12.1	13.1	9.3	7.6	5.4	4.2	3.1	2.1	1.0
14	10.6	11.6	8.2	6.7	4.9	3.8	2.8	1.9	1.0
12	9.1	10.1	7.2	5.9	4.3	3.4	2.6	1.8	1.0
10	7.6	8.6	6.2	5.1	3.8	3.0	2.3	1.7	1.0
8	6.1	7.1	5.1	4.3	3.2	2.6	2.0	1.5	1.0
6	4.6	5.6	4.1	3.5	2.7	2.2	1.8	1.4	1.0
4	3.0	4.0	3.1	2.6	2.1	1.8	1.5	1.3	1.0
2	1.5	2.5	2.0	1.8	1.6	1.4	1.3	1.1	1.0

Figure 3-1 illustrates a graph of the equalizer slope versus equalizer value information presented in Table 3-1. The amount of cable equals the equalizer value.

Figure 3-1
Equalizer slope versus cable



When selecting an equalizer, choose the next lower value if the exact value is not available or in cases where the calculated value makes two choices possible.

Because of errors in cable attenuation, slope in passive devices, and other independent variables, you may need to change the final value of the equalizer before you install the MB*/*.

Cable Simulators

STARLINE cable simulators, model SCS-*, are used in place of fixed equalizers in systems where: (1) the amplifiers are located close together, (2) there are large amounts of flat loss from passive components, or (3) it is necessary to compensate for reverse cable tilt. The simulators fit in the same location as the equalizers.

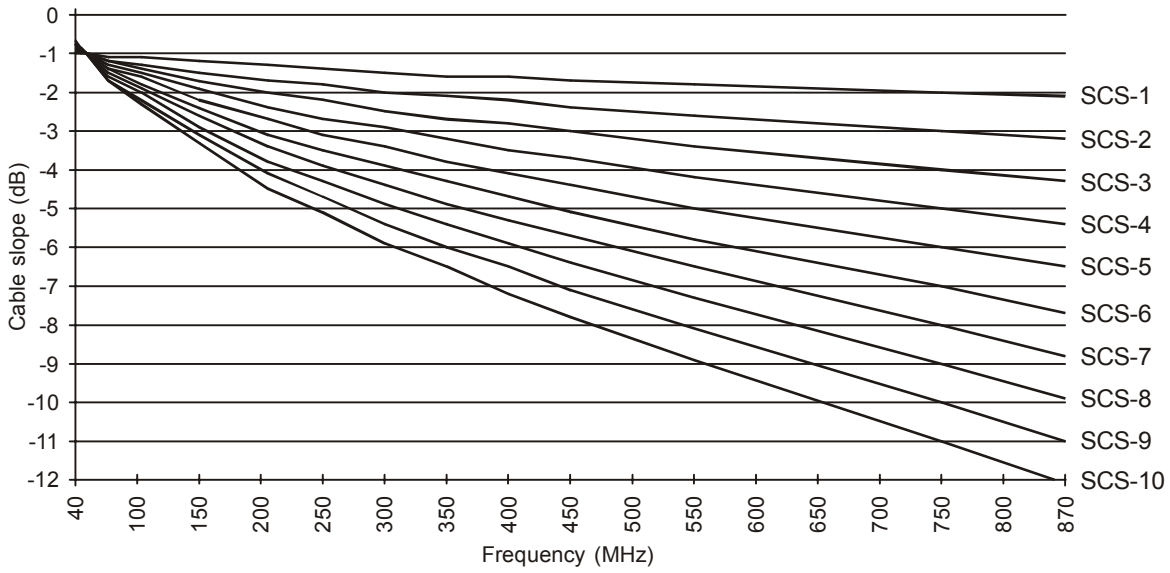
Table 3-2 and Figure 3-2 help you choose the correct simulators.

Table 3-2
Starline cable simulators

SCS-*	1	2	3	4	5	6	7	8	9	10
Frequency	Cable slope in dB									
40 MHz	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4
45 MHz	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
50 MHz	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72 MHz	-0.1	-0.2	-0.2	-0.3	-0.4	-0.4	-0.5	-0.6	-0.7	-0.7
108 MHz	-0.1	-0.3	-0.4	-0.5	-0.6	-0.8	-0.9	-1.0	-1.2	-1.3
150 MHz	-0.2	-0.5	-0.7	-0.9	-1.2	-1.4	-1.6	-1.9	-2.1	-2.3
211 MHz	-0.3	-0.7	-1.0	-1.4	-1.7	-2.1	-2.4	-2.8	-3.1	-3.5
250 MHz	-0.4	-0.8	-1.2	-1.7	-2.1	-2.5	-2.9	-3.3	-3.7	-4.1
300 MHz	-0.5	-1.0	-1.5	-1.9	-2.4	-2.9	-3.4	-3.9	-4.4	-4.9
350 MHz	-0.6	-1.1	-1.7	-2.2	-2.8	-3.3	-3.9	-4.4	-5.0	-5.5
400 MHz	-0.6	-1.2	-1.8	-2.5	-3.1	-3.7	-4.3	-4.9	-5.5	-6.2
450 MHz	-0.7	-1.4	-2.0	-2.7	-3.4	-4.1	-4.7	-5.4	-6.1	-6.8
550 MHz	-0.8	-1.6	-2.4	-3.2	-4.0	-4.8	-5.5	-6.3	-7.1	-7.9
750 MHz	-1.0	-2.0	-3.0	-4.0	-5.0	-6.0	-7.0	-8.0	-9.0	-10.0
870 MHz	-1.1	-2.2	-3.3	-4.4	-5.5	-6.7	-7.8	-8.9	-10.0	-11.1
50 MHz loss (typical)	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

The information in Table 3-2 is shown as a graph in Figure 3-2:

Figure 3-2
Frequency versus cable slope



Input, Midstage, and Output Pads

Install model JXP-*B pads to attenuate the signal per system design drawings. Generally, this consists of attenuating excessive input levels. You should pad the input to system level for unity gain. Select and install the specified pad in the socket labeled JXP-IN on the amplifier cover.

The midstage pad (JXP) and output pads (JXP2 and JXP3/4) can be used to adjust the gain level and achieve the gain specification. Refer to Section 6, “Operating Tips” for midstage/output padding information and recommendations.

Output Passives

Use the furnished JMP jumper to select port 3 or port 4 as the second output port. Install the proper output splitter to obtain signal output at port 3 and port 4. The SP splitter provides equal output at ports 3 and 4. If you require high-level output at port 3 or 4 and an 8 dB, 10 dB, or 12 dB lower level at the other port, install the appropriate DC/8, DC/10, or DC/12 directional coupler.

Figure 3-3 illustrates the SP splitter:

Figure 3-3
SP splitter

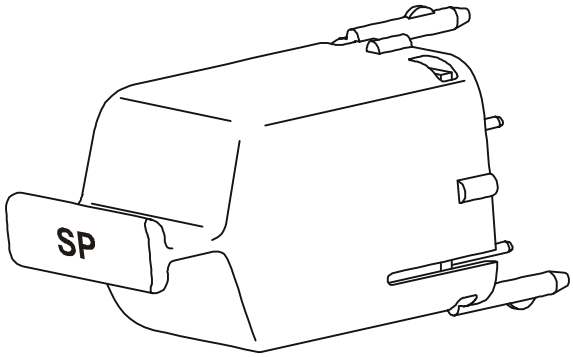
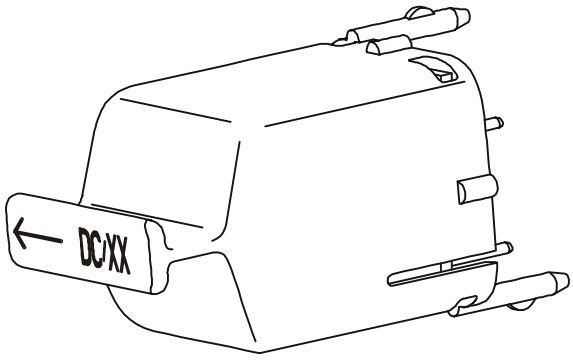


Figure 3-4 illustrates the DC/* directional coupler. The arrow indicates the tap port and therefore, the lower level.

Figure 3-4
DC/* directional coupler



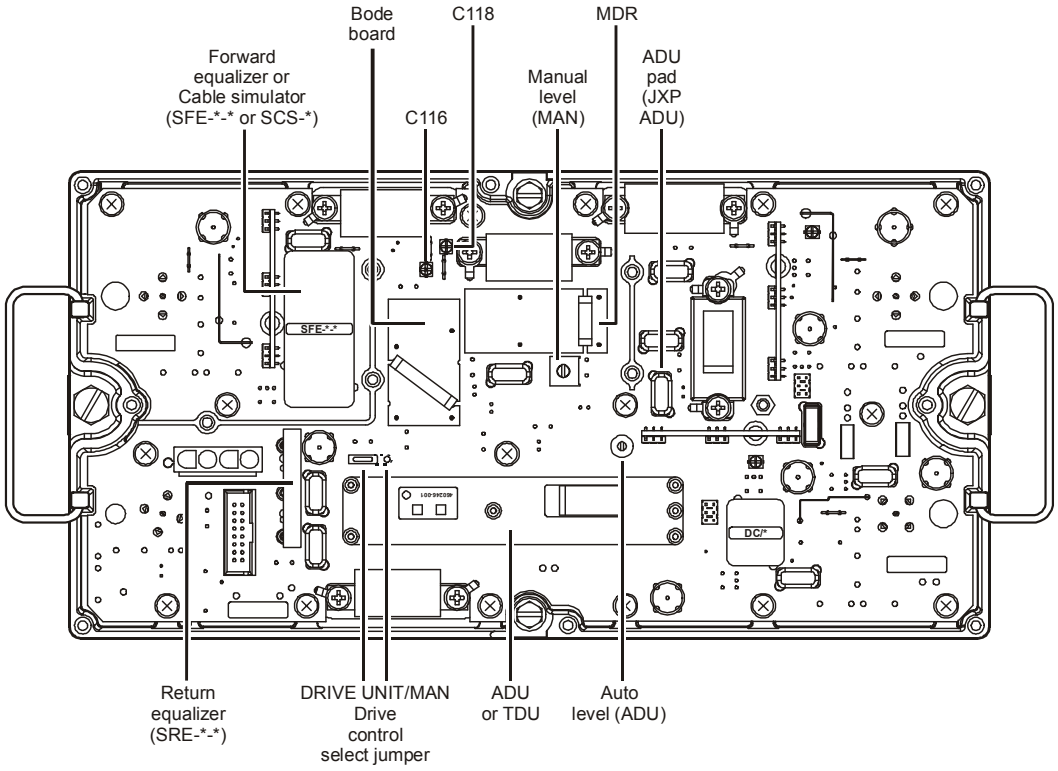
Flatness Control

All amplifiers are pre-aligned for optimal station flatness for the slope value ordered therefore, there is usually no need to adjust the MDR board. However, you can make minor adjustments, if necessary to achieve flatness across the passband.

The MDR-*MB/*/II board includes flatness controls and a fixed cable equalizer for 750 MHz or 870 MHz. This equalizer, plus the contribution of the hybrid gain stages, produces approximately the dB of slope indicated by the model number (12 dB of tilt with an MDR-*MB/12/II).

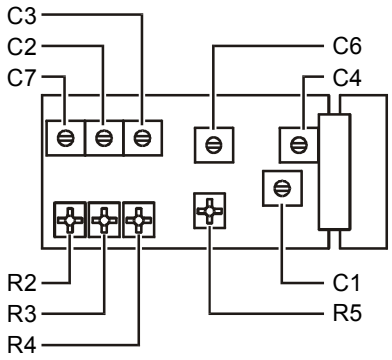
Adjust the MDR-*MB/*/II board and trimmer capacitors C116 and C118 on the main board to correct peak-to-valley response variations. Figure 3-5 illustrates the location of the MDR-*MB/*/II board and the two capacitors. Replace the equalizer if the response exhibits tilt.

Figure 3-5
Flatness controls



You can adjust the variable resistors and capacitors on the MDR-*MB/*/II board to flatten the response across the passband. Use C1, C2, C3, C4, C6, C7, R2, R3, R4, and R5 on the MDR-*MB/*/II board (illustrated in Figure 3-6) to obtain a flat response.

Figure 3-6
MDR-*MB/*/II board



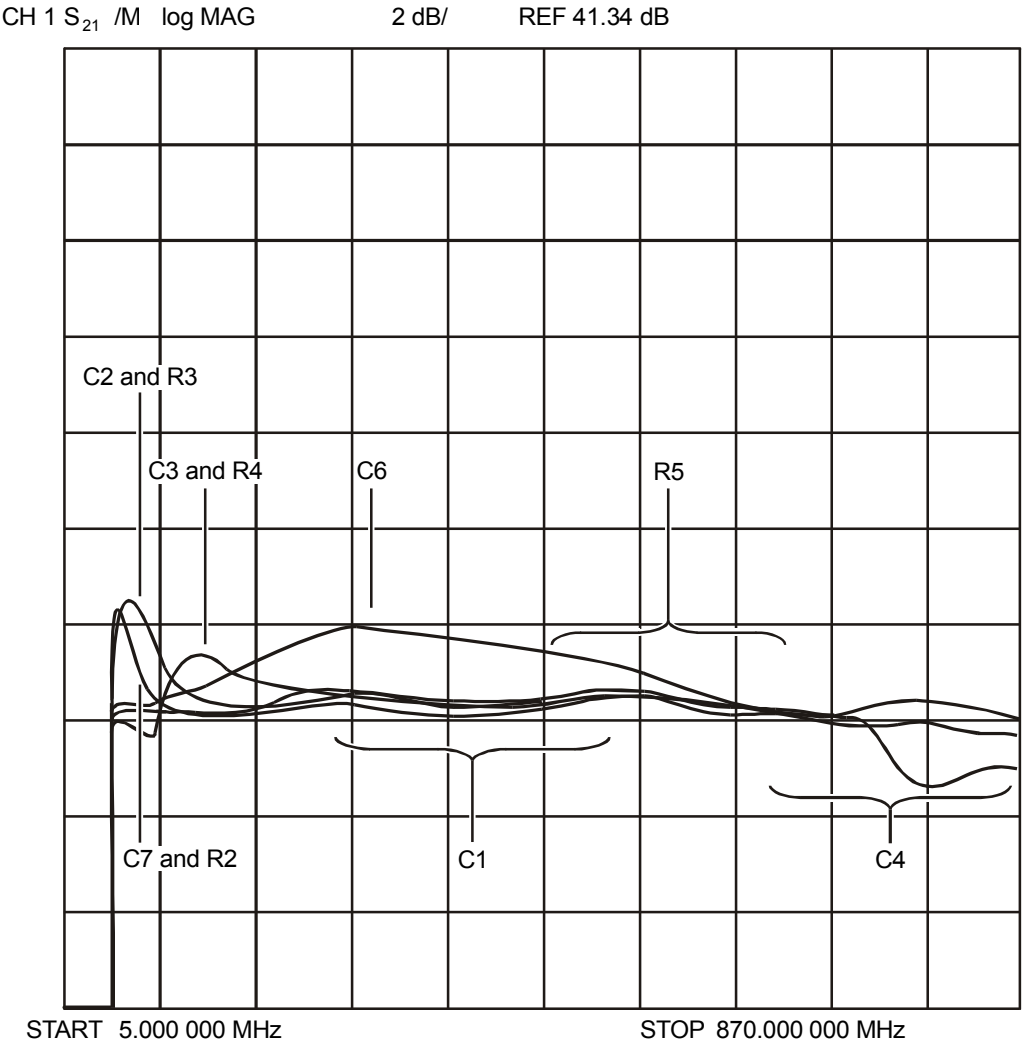
To obtain maximum flatness:

1. Adjust C6 and R5 for the flattest response in the mid- to lower-portion of the passband.
2. Adjust C1 for the flattest response in the low- to mid-range of the passband.
3. Adjust C3 and R4 for a peak at approximately 100 MHz to 300 MHz using the following steps:
   a. Set R4 to minimum resistance to show where the peak occurs for this RC network adjustment (R4/C3).
   b. Align C3 until the peak is near the mid-frequency limit.
   c. Increase R4 until the response is flat.
4. Adjust C2 and R3 for a peak at approximately the lowest forward frequency to 250 MHz using the following steps:
   a. Set R3 to minimum resistance.
   b. Align C2 until the peak is near 70 MHz above the lowest forward frequency.
   c. Increase R3 until the response is flat.
5. Adjust C7 and R2 for a peak at the lowest forward frequency using the following steps:
   a. Set R2 to mid-range.
   b. Align C7 until the peak is near the lowest forward frequency.
   c. Increase/decrease R2 until the response is flat.
6. Adjust C4 (and if necessary, L5, located on the bottom of the MDR board) to provide a bandwidth that extends past the highest forward frequency (750 MHz or 870 Mhz) by a minimum of 10 MHz.

Fine tune all of the above components for the best response. The low-end flatness controls compensate for the roll-off caused by the diplex filters. Air coils on the bottom of the MDR-*MB/*/II board may slightly tune the upper portion of the response.

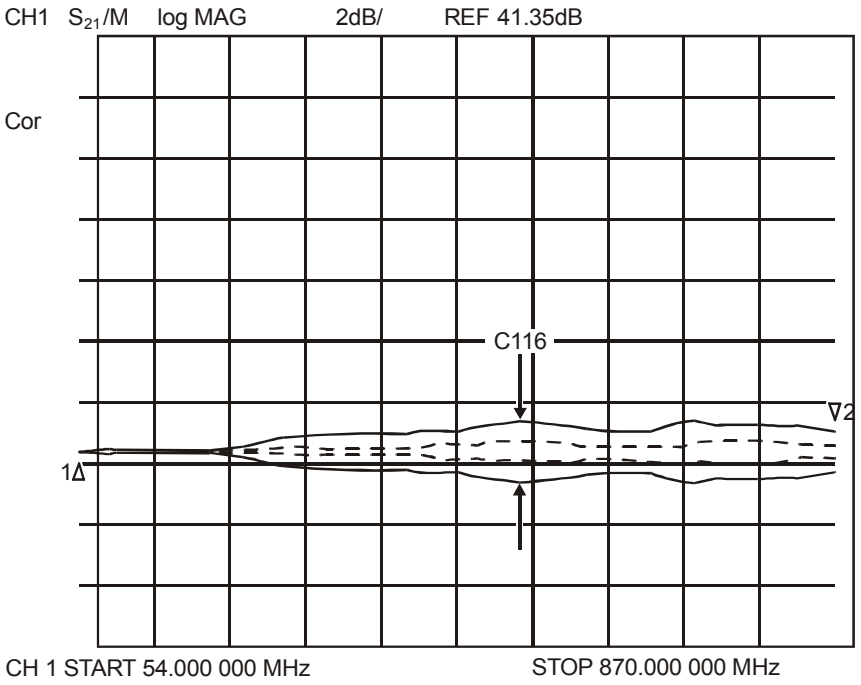
Figures 3-7 and 3-8 illustrate the approximate effects on the frequency response of the MB*/*:

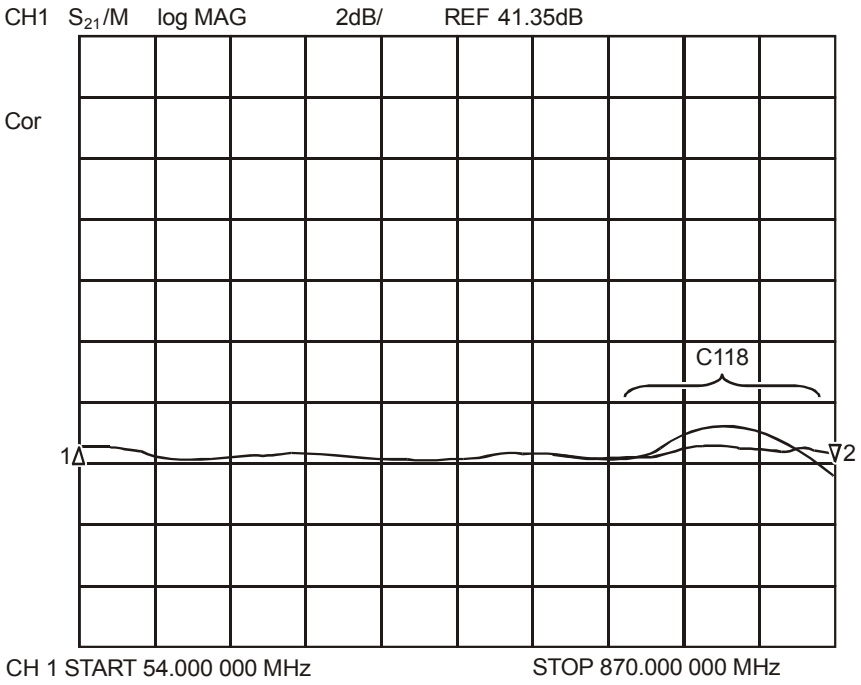
Figure 3-7
Effects of flatness controls on the MDR-8MB/*/II board



The changes in response were obtained by comparison against a normalized trace to emphasize the effect of the various controls.

Figure 3-8
Effect of flatness controls on the main board:





Directional Coupler Test Points

Accurate –20 dB directional-coupler test points are available at the input and at the output of the MB*/*. Because these test points are 75-ohm source impedance, they do not require special test probes.

After the output hybrid, a second directional coupler provides signal to the optional ADU board. This signal is used only when the ADU board is installed. It is not necessary to terminate this port when the ADU is not installed.

Bode Equalization

The Bode board, which is an electronically controlled equalizer, receives its control input from either the ADU or TDU control boards. The response of the Bode board compensates for cable attenuation changes due to temperature. If necessary, you can control the Bode board manually using the potentiometer labeled MANUAL LEVEL shown in Figure 3-5.

Amplifier Level Control

Signal levels vary in a cable system primarily because cable attenuation changes with temperature. Other components such as passives and amplifier hybrids are also affected by temperature changes. To automatically compensate for these signal level fluctuations and control output level, you must select the optional ADU or TDU. The use of the ADU or TDU is recommended for improved output level stability.

When necessary and appropriate, you can also use manual gain control. The gain of the MB*/* is then determined by the potentiometer marked MAN on the electronics chassis cover.

Manual Gain Control

To use manual gain control:

1. Verify that the electronics chassis is installed correctly.
2. Ensure that there is continuity in the forward path by installing the design-value forward equalizer and design value input JXP-*B attenuator.
3. Ensure that the drive control select jumper is in the MAN position.
4. Use a signal-level meter to measure the high band-edge carrier input level at the input test point: 750 MHz = channel 116, 870 MHz = channel 136.

   This carrier should be at standard analog level, non-scrambled.
5. Verify that the input level agrees with the design specification input.

   If the level is different from design, adjust accordingly. For example: the design level is 19 dBmV at the highest frequency and the design pad value is JXP-3B. If the actual measured level is 21 dBmV, then you must change the pad to a JXP-5B.

   If the actual levels are significantly different from the design levels, it is recommended that you investigate or consult system management before proceeding.
6. Connect the signal-level meter to the output test point and tune the meter to the high-end channel.
7. Turn the manual gain reserve (MAN) control (illustrated in Figure 3-5) to maximum (fully clockwise) and then reduce the output as noted in Table 3-3:

Table 3-3
Gain reserve versus ambient temperature

Temperature	Gain Reserve
Above 110°F (43°C)	4 dB
32°F (0°C) to 110°F (43°C)	5 dB
Below 32°F (0°C)	6 dB

8 Check the amplifier output tilt by measuring the high band- and low band-edge carriers.

- High = channel 116 (745.25 MHz) or channel 136 (865.25 MHz)
- Low = channel 2 (55.25 MHz) or channel 3 (61.25 MHz)
- If the tilt is less than required, install a higher value input equalizer
- If the tilt is greater than required, install a lower value input equalizer
- If the high value equalizer provides too much tilt and the low value equalizer provides too little tilt, use the lower value equalizer. Under-equalization is preferred to over-equalization.

If you use an SCS cable simulator and the design value is changed, you must also adjust the input pad. For each 1 dB increase in SCS value, 1 dB of loss is introduced at 750 MHz or 1.1 dB of loss at 870 MHz. Therefore, to maintain a proper gain level, it is necessary to adjust the input pad value as follows:

- For each increase in SCS value, decrease the input pad by 1 dB for the MB75* or 1.1 dB for the MB87*. Pads are available in 0.5 dB increments, therefore, use the closest value possible.
- For each decrease in SCS value, increase the input pad by 1 dB for the MB75* or 1.1 dB for the MB87*.
- If you replace an SFE with an SCS, reduce the value of the input pad by the value of the SCS for the MB75* or a good estimate for the MB87*. Use the 1 dB loss at 750 MHz to 1.1 dB loss at 870 MHz ratio to be exact.

9 Measure the output level at the highest frequency.

It should be within 1 dB of the system design level. If it is not, you must adjust the midstage pad (JXP) and/or the output pads (JXP 2 AND JXP 3/4) accordingly. Refer to Section 6, “Operating Tips,” for midstage/output padding information and recommendations.

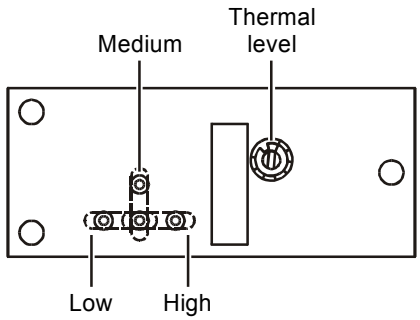
Thermal Drive Unit

The TDU senses temperature and controls the Bode board. It is assumed that the cable is subjected to the same or similar temperature; therefore, the TDU should not be used for underground installations.

To set-up the TDU:

1 Place the jumper on the TDU (Figure 3-9) to the LOW, MEDIUM, or HIGH position. This setting specifies the amount of cable for which the TDU compensates at the highest frequency preceding the MB*/* station. Low = 0 dB to 15 dB of cable, medium = 15 dB to 30 dB of cable, and high = 30 dB or more of cable.

Figure 3-9
TDU cable selector



2 Position the drive control select jumper (Figure 2-15) temporarily in the MAN position and perform the complete procedure described in Manual Gain Control if not already completed.

3 Position the drive control select jumper to DRIVE UNIT.

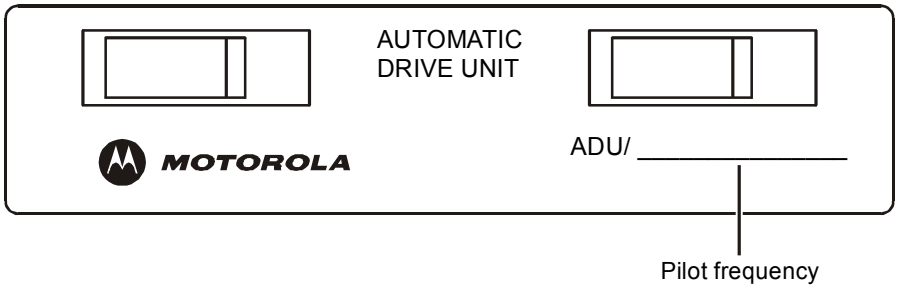
4 Connect a signal-level meter to the FWD OUT test point and tune the meter to the high band-edge carrier.

5 Turn the thermal level potentiometer on the TDU fully clockwise and then reduce to obtain the level obtained in Step 9 under Manual Gain Control.

Automatic Drive Unit

The ADU operates by using surface acoustic wave (SAW) filters to select a pilot frequency and then monitors the amplitude of this frequency. Any change in signal level is fed back to the Bode equalizer. It is assumed that the encountered signal level changes are due to changes in cable attenuation and hybrid output associated with a change in temperature. The Bode equalizer then changes its insertion loss to maintain a constant output level. The ADU (illustrated in Figure 3-10) maintains the most precise output level of the three available methods.

Figure 3-10
ADU



To set-up the ADU:

1. Position the drive control select jumper (Figure 2-15) temporarily to the MAN position and perform the complete procedure described in Manual Gain Control if not already completed.
2. Verify that the frequency stamped on the ADU control unit is the same as the system pilot frequency. The pilot frequency is a CW pilot or an available NTSC television channel not scrambled using sync suppression.
3. Position the drive control select jumper to DRIVE UNIT.
4. Connect a signal-level meter to the FWD OUT test point and tune the meter to the high band-edge carrier.
5. Turn the auto level (ADU) potentiometer (illustrated in Figure 2-15) fully clockwise and then reduce to obtain the level obtained in Step 9 under Manual Gain Control.

ADU Pads and Levels

This ADU subsection provides information regarding the proper ADU padding requirements for the MB*/*.

A JXP-*B pad is installed in the input line to the ADU location. This pad adjusts the ADU input level for the standard application of the MB*/* but can be changed depending on the operational output. In general, a JXP-14B pad is recommended in the MB*/* ADU circuit. This is the standard pad value shipped from the manufacturing facility and is appropriate for an amplifier output level range from +42 dBmV to +50 dBmV at 550 MHz.

Motorola does not recommend operating at levels above 52 dBmV.

Table 3-4 provides the AGC pad values for other output levels. Recommended pad values are shaded.

Table 3-4
MB*/* AGC pad levels

Amplifier	ADU Control Range (dBmV)		
MB*/* AGC Pad (10 to 14 dB tilt)	**Minimum Level at 547.25 MHz**	**Midpoint Level at 547.25 MHz**	**Maximum Level at 547.25 MHz**
6	35	39	43
7	36	40	44
8	37	41	45
9	38	42	46
10	39	43	47
11	40	44	48
12	41	45	49
14	42	46	50
15	43	47	51
16	44	48	52
17	45	49	53
18	46	50	54
19	47	51	55
20	48	52	56

The use of the ADU or TDU is recommended for improved output level stability although you can operate the MB*/* in the manual mode. Select manual mode by placing the drive control select jumper, illustrated in Figure 3-5, in the MAN position. The gain of the MB*/* is then determined by the potentiometer marked MAN on the amplifier cover.

Return Path Alignment

The following subsections describe the MB*/* alignment procedures required for proper performance in the return path.

Before You Begin

Before you begin to set-up the amplifier and perform return-path alignment, please read the following instructions and recommendations.

For proper return alignment obtain:

- RF alignment levels and insertion points for all MB*/*s
- RF reference output level of the headend optical receivers

Equipment required for return-path alignment includes:

- Full complement of JXP-*B pads and STARLINE Return Equalizers (SRE-*-*)
- Reverse signal generator — must produce at least one signal within the return bandpass and have variable output
- Return sweep or alignment equipment

It is recommended that you:

- Do not use wire jumpers to bypass the SRE-*-* location
- Perform the return optical link set up before performing amplifier set up
- Specify reverse alignment design levels for a single carrier
- Consider sweep equipment as a single carrier and operate at design levels
- Do not include injection point losses in reverse design levels

If JXP THERM devices (JXP-TH*B) are specified for level control, they should be installed in the JXP THERM pad facility (illustrated in Figure 2-15) prior to alignment.

Alignment Procedure

The return amplifier configuration includes one low-gain (25 dB) or one high-gain (30 dB) return amplifier hybrid, and an appropriate SRE-*-* equalizer. All components are plug-in and are easily installed.

To align the return path:

1. If the MB*/* is powered, remove all fuses before you perform the following steps.
2. If necessary, carefully install a reverse hybrid amplifier.
3. Ensure that both hybrid screws are tight. Torque the screws to 10 to 12 in-lbs. Over-torque can damage the hybrid.
4. Install the design value pad in the return output pad location (JXP).
5. Install the design value return equalizer, SRE-*-*, in the location “RTN EQ”.
6. Verify that the return input pad locations (JXP 2 and JXP 3/4) have 0 dB pads (or JXP-ZX jumpers) installed.
7. If the optional ICS is ordered, verify that the two switches (or one switch for single output MB*/S*) are installed in the ICS locations. Otherwise, leave the factory-installed jumpers in the two ICS locations.
8. Verify that the return pad (JXP COMMON) has a 0 dB pad (or JXP-ZX jumper) installed.
9. Verify that the return output pad socket (JXP THERM), located between the hybrid output and the SRE-*-*, has a 0 dB pad (or JXP-ZX jumper) or a JXP-TH*B installed.
10. Set the sweep equipment output level to the amplifier’s design input level. Add insertion point loss.
11. If required, change the return output pad (JXP) and/or return equalizer to achieve, as close as possible, a match of the reference level as compared to the node.
12. Verify the sweep response of all insertion points, if applicable.

13 Verify that the pad and equalizer values are similar to the map design values.

You can verify proper return alignment by injecting a carrier, at the design level, into any amplifier at random. Proper alignment is achieved if you observe the reference level at the headend optical receiver output.

Return levels used for alignment are not necessarily operational system levels. These levels vary from system to system due to differences in equipment, architectures and design philosophies. For an in-depth analysis and discussion of the return path, refer to Motorola reference guide *Return Path Level Selection, Setup and Alignment Procedure*.

Powering and Surge Protection

In conventional applications, MB*/*s are powered through the input port.

CAUTION!

To avoid damage to the hybrids, it is recommended that you remove the input pad (JXP-IN) before you apply power to the MB*/*.

A 20-ampere, blade-type fuse is furnished in the three active ports of the dual output amplifier module and provides overcurrent protection for ac power applied to the input. You can power the MB*/* from the output without passing power through to the input port. To block power from the input port, remove the 20-amp fuse (F1) located in the input port as illustrated in Figure 2-11.

WARNING!

To avoid possible injury to personnel or damage to the equipment, remove 60/90 volt ac power from the system before you remove any components from the housing.

The MB*/* is shipped from the factory configured for 38 through 90 Vac powering as described in Section 2, “Overview”. To configure the MB*/* for 55 Vac through 90 Vac operation:

1 Remove the power-supply cover.

2 Move the LO/HI selector (jumper J1 on the power-supply board) from the LO to HI position. Figure 2-10 illustrates the jumper location.

3 Re-install the power-supply cover and torque the screws to 10 to 12 in-lbs.

Standard surge protection is provided in the power supply by a heavy-duty, 230-volt, gas discharge surge protector. As an option, you can replace the gas discharge tube with the FTEC. The FTEC has a firing potential of approximately 245 volts.

To install the FTEC:

1 Remove the power-supply cover.

2 Remove the gas-tube surge protector, illustrated in Figure 2-10.

3 Replace it with the FTEC.

4 Re-install the power-supply cover and torque the screws to 10 to 12 in-lbs.

Section 4

Bench Testing

Motorola's recommended procedure for placing a new MB*/* into service is to fully test it on the bench before it is field installed. There are specific alignment procedures that ensure proper functioning of all components and simplify final installation. If the MB*/* is properly aligned on the bench, only minor adjustments may be required in the field.

The following subsections provide instructions to bench align the MB*/*.

Before You Begin

The MB*/* is shipped with a 20 ampere blade-type fuse in the three active ports of the dual output amplifier module for overcurrent protection.

CAUTION!

To avoid applying 60/90 Vac to the test equipment during testing, remove the fuse from the connected output port (F2 or F4) illustrated in Figure 2-11. Terminate all unused ports.

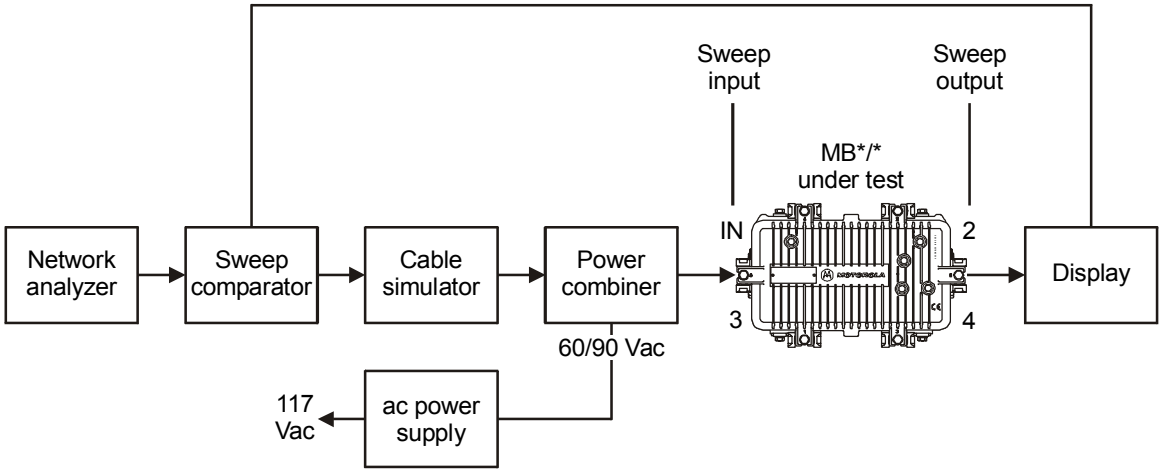
Open the housing and remove the chassis cover. Refer to your system drawings or records to confirm the presence of the required options as described in Section 2, "Overview," Options and Accessories.

Test Equipment and Connections

The equipment typically used for testing the MB*/* consists of a network analyzer, such as the HP 8711, 8712 or 8713 series, a model 1076 sweep comparator, and a model 1901C display or equivalent. In addition, you need a 60/90 Vac bench power supply, a Motorola model SSP-PIN power combiner, and a variety of jumper cables, adapters, and fittings.

Fabricate a cable simulator that you can configure to provide the desired cable loss in 1 dB increments up to approximately 30 dB. Then, connect the test equipment as shown in Figure 4-1:

Figure 4-1
Test equipment connections for bench sweeping



CAUTION!

To protect the network analyzer and sweep comparator, you must configure the SSP-PIN power combiner to block ac power from the input port.

To preserve signal quality, verify that all unused ports are terminated.

CAUTION!

Before you begin the following subsection, remove the input pad (JXP-IN) before you apply power to avoid damage to the hybrids.

Measuring Forward Gain

This subsection provides instructions for measuring the full gain and the operational gain and flatness of the MB*/*.

To measure the full gain of the amplifier:

1. Determine whether the power-supply jumper (J1) is positioned for LO or HI operation.
2. Connect the MB*/* to the test equipment as illustrated in Figure 4-1 and apply power.
3. Verify that the dc voltage is 24 V ± 0.4 V and re-install the input pad.
4. Apply the sweep signal and adjust test equipment as needed.
5. Select manual gain by placing the drive control select jumper in the MAN position and turn the MANUAL LEVEL control (Figure 2-15) fully clockwise.
6. Measure the gain at mixed forward frequency using the procedure outlined in the operator manual provided with the test equipment in use.

   To correct this number, add the insertion loss of the SSP-PIN power combiner (0.5 dB at 550 MHz, 0.6 dB at 750 MHz, or 0.7 dB at 870 MHz), the loss of the cable simulator at mixed forward frequency, and the loss of the cable equalizer (1.0 dB), if it is installed.

Example

The test equipment indicates a measured gain of 12.5 dB with an MB75S/* and the cable simulator is set to 20 dB.

0.6 dB (power combiner)
+ 1.0 dB (cable equalizer)
+ 20.0 dB (cable simulator)
+ 12.5 dB (measured gain).
34.1 dB (unit gain).

The result must meet advertised specifications for the unit.

The operational gain of the MB*/* provides reduced gain capability. This enables the unit to operate in the proper region of the Bode board when it is controlled by the ADU or TDU drive units.

To measure the operational gain and flatness of the amplifier:

1 Perform steps 1 through 6 in Measuring Forward Gain above.

2 Estimate the ambient temperature and find the required gain reserve by referring to Table 3-3. Reduce the gain at the highest frequency by the amount given in the table.

Example:

The ambient temperature is 70°F. The table indicates that the required gain reserve is 5 dB. Reduce the gain by 5 dB.

The operational gain is the sum of the measured gain after performing Step 2, plus all losses, such as power combiner, cable loss, equalizer, and cable simulator.

The sweep response is essentially flat at this point. If the response exhibits tilt, the cable equalizer must be changed. Install a higher equalizer value if the gain is greater at the low frequencies; install the next lower equalizer value if the gain is less at the low-end frequencies.

3 Measure the gain excursions from an average value within the bandpass.

The result is the peak-to-valley flatness. Some improvement is possible by adjusting the flatness controls on the MDR-*MB/*/II board as described in Section 3, “Amplifier Setup,” Flatness Control. Figure 3-6 illustrates the location of these controls on the MDR-*MB/*/II board.

Testing Return Gain and Response

After configuring the return path, you can test the return bandpass to ensure compliance with specifications. When testing the return amplifier, remember that it is a flat amplifier. Therefore, the cable simulator must remain in the test setup and must remain set to the same cable equivalent as in the forward sweep test. This provides an approximate indication of the frequency response, which you can achieve in the field.

To test for return gain and response:

1 Reconnect the test equipment and switch the *sweep input* and *sweep output* leads of the MB*/* under test to be opposite of the connection shown in Figure 4-1.

2 Remove the 20 A fuse (F IN) at the input port and replace the 20 A fuse (F2 or F4) at the output port (Port 2 or Port 4) (Figure 2-11) before you apply power.

3 Re-adjust the test equipment to sweep from 4 MHz through the maximum return band frequency plus 10 MHz.

The expected response is flat. Any tilt, which is due to the return equalizer, must average out to a flat response in a cascade of amplifiers. A slope adjustment is not available in the return bandpass.

4 Measure the gain at the maximum return band frequency (example, 40 MHz for S-split).

The amplifier gain is the sum of: the measured gain, the insertion loss of the return cable equalizer at the maximum return band frequency, the insertion loss of the power combiner, any pads installed in either the input or output pad locations, plus the cable simulator loss at the maximum return band frequency. The measured gain must meet advertised specifications for the return amplifier.

Example

12.5 dB (measured gain)
+ 1.0 dB (equalizer insertion loss)
+ 0.6 dB (power combiner)
+ 0.0 dB (pads)
+ 4.6 dB (cable simulator at 40 MHz)
18.7 dB (unit gain)

Completing the Test Procedures

The amplifier is now approximately tailored for a specific field location. Additional adjustments after installation are minor in nature. Re-install the fuses removed during testing.

Complete station records by recording pertinent information. Remove test-equipment connections and close the housing following instructions provided in Section 5, “Installation,” Closing the Housing.

Section 5
Installation

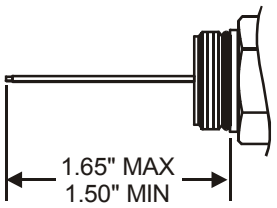
The field installation procedures presented in the following subsections assume that the amplifier was previously tested and bench aligned. Cable power and RF signal must be available on the system. Although it is preferable to have a full complement of channels available for balancing, you can adjust the MB*/* adequately with a limited number of channels.

You can install the MB-HSG or MBP-HSG on a messenger strand (aerial) or on a pedestal. The following subsections provide details on each application.

Aerial Installation

The housing is normally mounted without the electronics chassis to avoid possible damage during installation. Connections are made using standard pin-type connectors with a nominal center-conductor diameter of 0.067 inches. The minimum length of the center-conductor pin is 1.5 inches and the maximum length is 1.65 inches. Longer pins can extend past the center-conductor seizure mechanism and degrade the match. Extremely long pins can result in a short circuit.

Figure 5-1
Center-conductor pin length



To install the unit:

1. Power down the cable before you install the housing. This avoids blown fuses, tripped circuit breakers, and possible personal injury.
2. Mount the housing and torque the two 5/16-inch messenger clamp bolts, located on the long sides of the housing, (illustrated in Figures 2-4 and 2-7) to 10 to 12 ft-lbs.
3. Form the customary expansion loops and make all cable connections according to system design.
   a. Tighten the center-conductor seizure screw using a Phillips-head screw driver. An alternative method is to use a 3/16-inch socket and a torque wrench. The recommended torque is 12 in-lbs. maximum.
   b. To avoid water ingress, ensure that aluminum connectors are torqued to the specifications recommended by the connector manufacturer.
4. If previously removed, re-install the electronics chassis and fasten it to the housing with the four captive bolts. Torque to 18 to 22 in-lbs.
5. *Remove the input pad (JXP-IN) to avoid damage to the hybrids.*
6. Apply power to the unit and allocate a few minutes for warm up.

7 Check the ac voltage setting (jumper J1, Figure 2-10).

J1 position	Description
LO	The voltage must be greater than 38 Vac as read with a true rms voltmeter or 42 Vac when using a conventional, average reading, ac voltmeter.
HI	The voltage must be greater than 55 Vac when read with a true rms voltmeter or 61 Vac when using a conventional, average reading, ac voltmeter.

8 Check the dc voltage. Verify that it is between 23.6 V and 24.4 V and reinstall the input pad.

9 If necessary, rebalance the amplifier following the instructions in Section 3, “Amplifier Setup.”

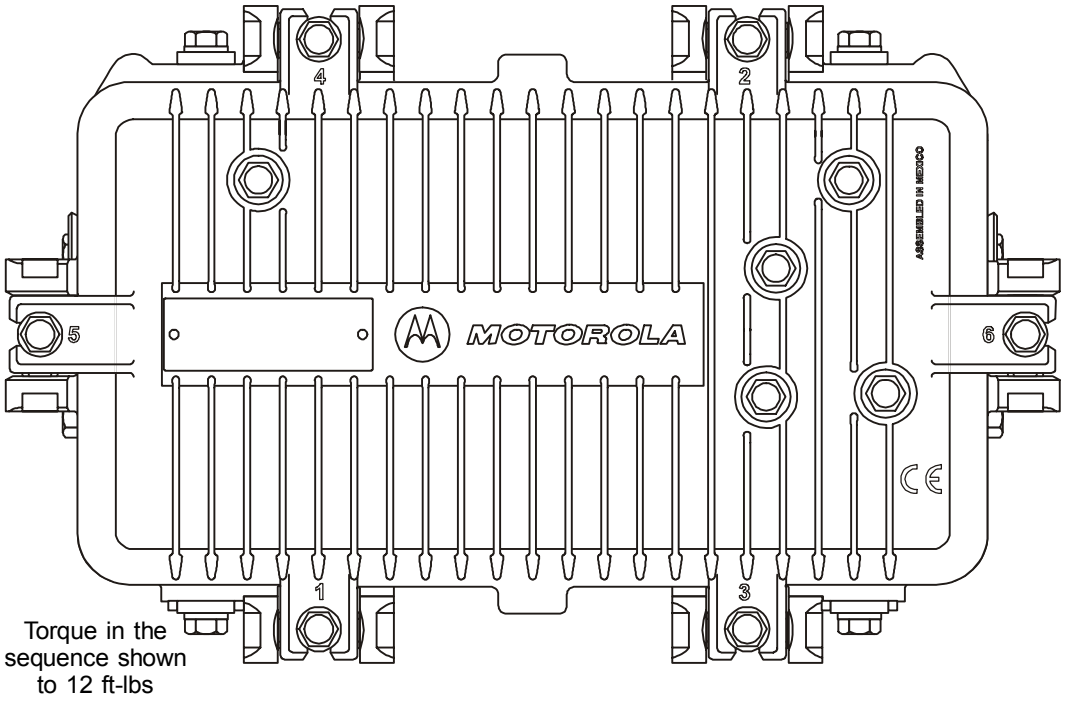
10 Check the tightness of the electronic chassis cover screws (10 to 12 in-lbs.) and electronics chassis hold-down bolts (18 to 22 in-lbs.).

11 Check the condition of the RF and weather gaskets and replace them if necessary. If needed, also apply a light coating of silicone grease.

12 Ensure that the electronic chassis handles are folded down and that the cable between the power pack and the electronics chassis is not pinched.

13 Close the housing and use a torque wrench to sequentially and progressively tighten the housing bolts to a final torque of 12 ft-lb in the sequence specified on the housing cover and illustrated in Figure 5-2.

Figure 5-2
Torque sequence



Pedestal Installation

Pedestal installation is similar to the aerial installation with the exeception of temperature and mounting procedure. In an aerial installation, the cable and amplifier are subject to the same temperature. In contrast, pedestal installation provides a stable temperature environment for the buried cable while subjecting the elevated amplifier to higher temperatures. The ADU, if installed, functions the same as in an aerial installation and does not require further attention. See Section 3, "Amplifier Setup," Amplifier Level Control for additional information.

Manual thermal compensation provided by the TDU can be inaccurate and result in signal level changes with ambient temperature change. One approach to this problem is to select the least amount of cable setting (low) on the TDU. This results in minimal gain change with temperature. A preferred approach is to install a JXP-TH*B thermal attenuator while operating the MB*/* in the manual mode.

To mount the MB*/* on a pedestal:

1. Remove two 5/16-inch messenger clamp bolts located on the long sides of the MB*/* housing.
2. Locate the two 5/16-inch holes 7.7 inches center-to-center cast in the lower housing.
3. Use the two 5/16-inch bolts to install the MB*/* to the pre-drilled pedestal mounting plate and torque to 10 to 12 ft-lbs.

Section 6

Operating Tips

This section describes using amplifiers in lower frequency systems and in lower gain systems.

Using Amplifiers in Lower Frequency Systems

When using the MB*/* in 750 MHz or 550 MHz systems, you must consider the best method for handling the reduced bandwidth and channel-loading requirement. The following information helps you determine the best approach.

For distribution systems designed and installed as 870 MHz systems, but carrying a reduced channel load, there are no further concerns. You can add or remove channels at your discretion. If the system operates with ADUs, the pilot channel cannot be disturbed. Reduced channel loading improves distortion.

For lower-frequency systems, such as 750 MHz or 550 MHz, to maintain amplifier gain it is optimal to use the amplifier and equalizers that match the system frequency. For example, 750 MHz equalizers used in 550 MHz systems, result in reduced amplifier gain. Note also, that the equalizer cuts off at the frequency value for which it is designed. For example, an SFE-75-* cuts off frequencies above 750 MHz. Therefore, if you have an 870 MHz system and need the equalizer to perform to 870 MHz, you should use an SFE-87-*. In the MB*/* the SFE, as well as the MDR, are designed and optimized to a specific passband. When possible, in addition to using the equalizers that correspond to your system frequency, also install the amplifiers designed for that frequency. For example, in a 750 MHz system, a 750 MHz amplifier is preferred but not required.

Using Amplifiers in Lower Gain Systems

There are three pad facilities in the forward path: (1) is the pad location (JXP-IN) at the input to the amplifier, (2) is the midstage pad (JXP) located between the pre-amplifier and the interstage hybrid, and (3) are the output pads (JXP 2 and JXP 3/4) located between the interstage hybrid and the output hybrids.

The input pad (JXP-IN) is normally changed to accommodate excessive input levels. When operating at the same output levels, an MB*/* with an input pad has the same carrier-to-noise (c/n) and distortion performance as an MB*/* without the input pad. Because it only attenuates excess signal, it has no effect on the overall performance of the MB*/*.

If necessary, to achieve the gain specification, you can use the midstage pad (JXP) or output pads (JXP2 and JXP 3/4) to reduce the gain of the MB*/*. However, this will affect amplifier performance. Output padding degrades the station distortion performance while having minimal effect on the carrier-to-noise performance. Midstage padding is the opposite and therefore has little effect on distortions, but degrades the carrier-to-noise performance. In general, we recommend you pad to the gain specification on the output. However, if you are unsure about the optimal padding technique for your system, we recommend you split the required padding evenly between the midstage and output pad(s).

It is recommended that you contact Motorola's TRC or your account representative for more specific information regarding use of the midstage and output pads.

Appendix A

Specifications

Specifications are valid over the given bandpass and operating temperature range of –40°F to +140°F (–40°C to +60°C). Specifications are stated typical unless otherwise noted, and are subject to change. Refer to the Motorola BCS web site or contact your account representative for the latest specifications.

Model MB87S/XG*

Specification	Forward Amplifier		
Passband	52 through 870 MHz		
Gain			
Full	45 dB (with SFE-*-*)		
Operational	40 dB (with SFE-*-* and slope reserves)		
Flatness			
52 through 870 MHz	±0.75 dB maximum		
Level control, automatic	Bode board using ADU/TDU		
Gain control	Fixed pads, JXP-∗B		
Performance - reference frequency (MHz)	870/750/52	870/550/52	870/550/52
At typical output (dBmV)	43/47/37	47.5/48.5/41.5	43/44/37
Channels	112 analog/120 MHz digital (suppressed by 6 dB)	79 analog/320 MHz digital (suppressed by 6 dB)	79 analog/320 MHz digital (suppressed by 6 dB)
Crossmod (worst case)	–60 dB	–56 dB	–65 dB
CTB (worst case)	–63 dB	–67 dB	–75 dB
CSO (worst case)	–65 dB	–66.5 dB	–71 dB
Noise figure			
At 52 MHz	12 dB (with SFE-1)		
At 870 MHz	10 dB (with SFE-1)		
Interstage equalizer, MDR-8MB/12/G/II	12 ±1 dB		
Hum modulation	–65 dB		
Return loss, input/output	16 dB at operational level		
Test points, input/output	20 ±1.0 dB		
Housing dimensions	15.4 L × 5.5 W× 9.6 D inches (39.1 × 13.97 × 24.3 cm)		
Weight	15 pounds (6.8 kg)		

Model MB87S/XX*

Specification	Forward Amplifier	
Passband	52 through 870 MHz	
Gain		
Full	45 dB (with SFE-*-*)	
Operational	40 dB (with SFE-*-* and slope reserves)	
Flatness		
52 through 870 MHz	±0.75 dB maximum	
Level control, automatic	Bode board using ADU/TDU	
Gain control	Fixed pads, JXP-∗B	
Performance - reference frequency (MHz)	870/750/52	870/550/52
At typical output (dBmV)	43/47/37	43/44/37
Channels	112 analog/120 MHz digital (suppressed by 6 dB)	79 analog/320 MHz digital (suppressed by 6 dB)
Crossmod (worst case)	–62 dB	–67 dB
CTB (worst case)	–61 dB	–71 dB
CSO (worst case)	–67 dB	–75 dB
Noise figure		
At 52 MHz	12 dB (with SFE-1)	
At 870 MHz	10 dB (with SFE-1)	
Interstage equalizer, MDR-8MB/12/II	12 ±1 dB	
Hum modulation	–65 dB	
Return loss, input/output	16 dB at operational level	
Test points, input/output	20 ±1.0 dB	
Housing dimensions	15.4 L × 5.5 W× 9.6 D inches (39.1 × 13.97 × 24.3 cm)	
Weight	15 pounds (6.8 kg)	

Model MB75S/XG*

Specification	Forward Amplifier		
Passband	52 through 750 MHz		
Gain			
Full	45 dB (with SFE-*-*)		
Operational	40 dB (with SFE-*-* and slope reserves)		
Flatness			
52 through 750 MHz	±0.75 dB maximum		
Level control, automatic	Bode board using ADU/TDU		
Gain control	Fixed pads, JXP-∗B		
Performance - reference frequency (MHz)	750/52	750/550/52	750/550/52
At typical output (dBmV)	47/37	45.5/48.5/41.5	41/44/37
Channels	112 analog	79 analog/200 MHz digital (suppressed by 6 dB)	79 analog/200 MHz digital (suppressed by 6 dB)
Crossmod (worst case)	–60 dB	–56 dB	–65 dB
CTB (worst case)	–63 dB	–67 dB	–75 dB
CSO (worst case)	–65 dB	–66.5 dB	–71 dB
Noise figure			
At 52 MHz	12 dB (with SFE-1)		
At 750 MHz	10 dB (with SFE-1)		
Interstage equalizer, MDR-7MB/10/G/II	10 ±1 dB		
Hum modulation	–65 dB		
Return loss, input/output	16 dB at operational level		
Test points, input/output	20 ±1.0 dB		
Housing dimensions	15.4 L × 5.5 W× 9.6 D inches (39.1 × 13.97 × 24.3 cm)		
Weight	15 pounds (6.8 kg)		

Model MB75S/XX*

Specification	Forward Amplifier	
Passband	52 through 750 MHz	
Gain		
Full	45 dB (with SFE-*-*)	
Operational	40 dB (with SFE-*-* and slope reserves)	
Flatness		
52 through 750 MHz	±0.75 dB maximum	
Level control, automatic	Bode board using ADU/TDU	
Gain control	Fixed pads, JXP-∗B	
Performance - reference frequency (MHz)	750/52	750/550/52
At typical output (dBmV)	47/37	41/44/37
Channels	112 analog	79 analog/200 MHz digital (suppressed by 6 dB)
Crossmod (worst case)	–59 dB	–68 dB
CTB (worst case)	–57 dB	–69 dB
CSO (worst case)	–59 dB	–68 dB
Noise figure		
At 52 MHz	12 dB (with SFE-1)	
At 750 MHz	10 dB (with SFE-1)	
Interstage equalizer slope, MDR-7MB/10/II	10 ±1 dB	
Hum modulation	–65 dB	
Return loss, input/output	16 dB at operational level	
Test points, input/output	20 ±1.0 dB	
Housing dimensions	15.4 L × 5.5 W× 9.6 D inches (39.1 × 13.97 × 24.3 cm)	
Weight	15 pounds (6.8 kg)	

AC Current, MB75*/*, MB87*/*

AC Voltage	One-way (typical E-GaAs)	With RA-Kit (typical E-GaAs)	One-way (typical Silicon)	With RA-Kit (typical Silicon)
90 Vac	0.51 A	0.55 A	0.48 A	0.53 A
75 Vac	0.62 A	0.68 A	0.59 A	0.65 A
60 Vac	0.74 A	0.81 A	0.71 A	0.78 A
53 Vac	0.85 A	0.92 A	0.81 A	0.89 A
45 Vac	0.95 A	1.08 A	0.95 A	1.04 A
38 Vac	1.20 A	1.31 A	1.14 A	1.25 A

RA-Kit/H Return Amplifier

Parameter	Specification
Passband	5 through 40 MHz
Gain, station (minimum)	20 dB (18 dB for M-split)
Flatness	±0.50 dB
Level control	Fixed pads, JXP-∗B, input and output
Performance – reference frequency (MHz)	40
At typical output	41 dBmV, flat
Channels	4 NTSC
Crossmod	–69 dB
Single triple beat	–78 dB
Single second order	–76 dB
Noise figure	9 dB
Power requirements	24 Vdc, 125 mA

ADU Automatic Drive Unit

Parameter	Specification
Pilot channel	See current catalog
Adjacent channel frequency	±6 MHz
Minimum MB*/* output at pilot frequency	+36 dBmV
ALC stiffness	±0.3 output change for ±3.0 dB input change
Power requirement	24 Vdc, 75 mA

Appendix B

Torque Specifications

Torque specifications are valid for the MB*/*.

Fastener	Screw Size	Wrench Size	In-lbs	Torque Ft-lbs	N•M
Strand clamp/pedestal mounting	5/16-18	1/2 inch	120-144	10-12	13.6-16.3
Housing/lid closure	5/16-18	1/2 inch	144	12.0	16.3
Test point plugs	5/8-24	1/2 inch	25-40	2.1-3.3	2.8-4.5
Seizure screw	#8-32	3/16 inch or Phillips	12	1.0	1.4
Hybrid	#6-32	Phillips	10-12	0.8-1.0	1.1-1.4
Chassis (electronics module)	#10-32	5/16 inch	18-22	1.5-1.8	2.0-2.4
Chassis cover	#6-32	1/4 inch or Phillips	10-12	0.8-1.0	1.1-1.4
Status monitor	#10-32	5/16 inch	24-30	2.0-2.5	2.7-3.4
Power supply cover	#6-32	1/4 inch or Phillips	10-12	0.8-1.0	1.1-1.4

Torque specifications are valid for the MB-BYPASS*/*.

Fastener	Screw Size	Wrench Size	In-lbs	Torque Ft-lbs	N•M
Strand clamp/pedestal mounting	5/16-18	1/2 inch	120-144	10-12	13.6-16.3
Housing/lid closure	1/4-20	7/16 inch	72	6.0	8.1
Test point plugs	5/8-24	1/2 inch	25-40	2.1-3.3	2.8-4.5
Seizure screw	#8-32	3/16 inch or Phillips	12	1.0	1.4
Hybrid	#6-32	Phillips	10-12	0.8-1.0	1.1-1.4
Chassis (electronics module)	#10-32	5/16 inch	18-22	1.5-1.8	2.0-2.4
Chassis cover	#6-32	1/4 inch or Phillips	10-12	0.8-1.0	1.1-1.4
Status monitor	#10-32	5/16 inch	24-30	2.0-2.5	2.7-3.4
Power supply cover	#6-32	Phillips	10-12	0.8-1.0	1.1-1.4

Abbreviations and Acronyms

The abbreviations and acronyms list contains the full spelling of the short forms used in this manual.

ADU	Automatic Drive Unit
c/n	carrier-to-noise
CSO	Composite Second Order
CTB	Composite Triple Beat
cw	Continuous wave
dB	Decibel
dBmV	Decibels referenced to one millivolt
FTEC	Fast Transfer Electronic Crowbar
ICS	Ingress Control Switch
MHz	Megahertz
NTSC	National Television Standards Committee
rms	root-mean-square
RSA	Return for Service Authorization
SAW	Surface Acoustic Wave
SCS-*	STARLINE Cable Simulator
SFE-*-*	STARLINE Forward Equalizer
SRE-*-*	STARLINE Return Equalizer
TDU	Thermal Drive Unit
TRC	Technical Response Center

MOTOROLA

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